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CATFISH CREEK DRAINAGE BASIN STUDY

Surface Water Hydrology, Quality, Biology and Waste Loading Guidelines

1978

Ministry of the Environment

Ontario

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Surface Water Hydrology, Quality, Biology and Waste Loading Guidelines

Water Resources Assessment Unit
Technical Support Section
Southwestern Region

Ministry of the Environment 1978

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SUMMARY AND RECOMMENDATIONS

During 1976, studies were conducted to document chemical, bacteriological and biological conditions in Catfish Creek as a measure of the effects of discharges from sewage treatment facilities at the Ontario Police College and from the Town of Aylmer.

Streamflow data from Federal Gauging Station 02GC018 at Sparta were analysed and pro-rated to supply flows in the various urban sub-basin areas. At Brownsville, at the Ontario Police College and at Springfield, streamflows are known to be essentially zero during the summer and fall periods. At Aylmer, the present wastewater flows to the lagoons are approximately equal to the one-in-ten year, minimum monthly average July and August streamflows.

The water quality data show that this Ministry's bacteriological criteria for livestock watering and irrigation were exceeded at all stations in the Basin. On the last day of the survey, rainfall occurred and the bacterial levels increased significantly downstream from Aylmer. The sub-watershed containing the Village of Springfield contributed the highest bacteriological concentrations during the survey. The Town of Aylmer has several combined storm and sanitary sewers that by-pass to Catfish Creek and agricultural and storm water runoff also contribute to the adverse bacteriological conditions.

No intolerant macroinvertebrates or fish species were recovered at some stations as a result of natural conditions in the stream. However, waste inputs from various sources also affected the biological community. Intolerant macro-invertebrate populations were depressed (absence of mayflies)

during May and July immediately downstream from the Aylmer lagoons which indicates that a condition of stress occurred over the winter. The stress was probably a combination of toxic conditions and low dissolved oxygen concentrations. Low dissolved oxygen concentrations were recorded downstream from Springfield and the Ontario Police College. Excessive aquatic plant growths were noted in Catfish Creek through and below Aylmer during both biological sampling periods in 1976. There was an increase in phosphorus levels in the stream as a result of the discharge from the Aylmer lagoons and from urban runoff from the Town. Agricultural inputs such as runoff from fields and direct discharges to the Creek from intensive feedlot operations have all affected water quality.

The following measures are recommended to protect water quality and aquatic life in the Catfish Creek Drainage Basin:

1. All controllable sources of bacteriological pollution to the river system should be removed or reduced.

2. The Town of Aylmer should expand its existing lagoon system to retain sewage flows generated during the summer period (May 1 to October 31). A continuous feed of chemical for phosphorus removal particularly through the winter must be included in the sewage works. A batch dose in the fall can be considered. Discharge in proportion to streamflow will be permitted providing the stream criteria given in this report are maintained. If the criteria are not achieved, additional storage or treatment works will be required.

3. The sewer separation program for the Town of Aylmer should proceed in order to reduce organic, nutrient and bacteriological loadings to Catfish Creek. Further study may be required to determine if quality control measures are required for storm water.

4. If private sewage treatment systems fail to provide adequate treatment then a communal sewage collection and treatment system consisting of a waste stabilization pond with at least six months storage and a continuous feed of chemical for phosphorus removal is recommended for Brownsville. Batch dosing for phosphorus removal during the fall can be considered. Additional storage or treatment works may be required if the stream criteria cannot be achieved.

5. If the proposed communal sewage works for the Village of Springfield proceeds, a waste stabilization pond system with at least six months storage and a continuous feed of chemical for phosphorus removal is recommended. Batch dosing for phosphorus removal during the fall can be considered. The discharge should be directed to the confluence of two tributaries about 0.8 kilometers (1/2 mile) south of the Village to obtain additional dilution. Additional storage or treatment works may be required if stream criteria cannot be achieved.

6. The sewage treatment plant at the Ontario Police College has undergone a major renovation since the 1976 surveys and it is expected that the effluent has improved from that recorded in this report. If problems are identified in the stream as a result of the continuous discharge from this plant, storage of the effluent will be required probably from May to October. In this event the discharge would be directed either to the main branch of Catfish Creek or to the tributary passing through Springfield. A continuous feed of chemical for phosphorus removal will still be required, particularly for a spring discharge. A batch-dosing procedure for the fall discharge can be considered. Another alternative is the diversion of the effluent to the wild fowl area operated by the Ministry of Natural Resources.

7. Agricultural practices such as those outlined below should be implemented to reduce organic, nutrient, solids and bacteriological loadings to Catfish Creek:

   a. Fertilizer should be applied at rates recommended by the Ontario Ministry of Agriculture and Food and should be based on soil tests.

   b. Runoff from feedlots and silage storage areas should be controlled before reaching streams. Manure and liquid wastes should be applied to unfrozen ground and should be worked into the ground to ensure that wastes do not gain direct entry to the watercourse.

   c. Livestock access to streams in the basin should be restricted so that direct inputs of animal wastes are reduced and so that erosion of streambanks is reduced.

   d. Adequate stream buffers along all open channels should be provided to reduce erosion and to retard overland runoff.

   e. Agricultural drainage practices should be conducted in a manner to minimize soil losses, including the following: use of varying slopes along open drains depending on soil characteristics (i.e. more gradual slopes required for lighter soils), proper tile outlets, minimal disruption of vegetative cover and/or re-seeding of ditch banks following clean-out operations. Grassed waterways should be utilized wherever possible.

f. Where soil conditions permit (i.e. lighter soils), erosion losses should be reduced by leaving corn stubble and other crop residues on the land over fall and winter periods (i.e., spring ploughing) and minimum tillage practices should be followed.

INTRODUCTION

A study was undertaken from July 12 to July 15, 1976, to determine water quality and quantity characteristics of Catfish Creek, to identify areas of water quality impairment and to recommend waste loading guidelines for the population centres in the watershed. Particular emphasis was placed on reaches receiving treated wastes from the Town of Aylmer, and from the municipalities of Springfield and Brownsville which are serviced by individual septic tank systems. Developmental pressures continue to be exerted in these municipalities. Emphasis was also placed on the unnamed tributary to which the Ontario Police College discharges treated wastes.

Water quality was determined by monitoring chemical, physical and bacteriological characteristics for a 72-hour period in July. Responses of aquatic life were documented through studies of fish and bottom fauna populations in May and July and in September and October, 1976. Long-term streamflow data were utilized to define streamflow characteristics in critical areas. Water quality information gathered as part of this Ministry's on-going monitoring program was also used to advantage in assessing in-stream water quality conditions.

Waste loading guidelines designed to protect water uses in Catfish Creek are presented in this report.

BASIN DESCRIPTION AND WATER USE

Catfish Creek rises at an elevation of approximately 251 meters (825 feet) above sea level and flows about 41 kilometers (25 miles) in a southerly direction to Port Bruce. The creek has an average gradient of approximately 3.1 meters per kilometer (6.4 feet per mile). The watershed drains approximately 35,000 hectares (135 square miles) of predominantly agricultural land in Elgin County and a small section of the southwestern corner of Oxford County (Figure 1).

The portion of the watershed upstream from the Federal Stream Gauge 02GC018 is drained by Catfish Creek and 2 major tributaries, West Catfish Creek and East Catfish Creek, all of which flow in a south-westerly direction until they unite near New Sarum; thereafter, the direction of flow is essentially South.

As the physiographic map in Figure 1 shows, East and West Catfish creeks flow along ancient spillway deposits above the shoreline of glacial Lake Whittlesey. From this shoreline to the main branch, East and West Catfish creeks flow through the Ekfrid Clay Plain. Between the confluence and Lake Erie, Catfish Creek flows through the Norfolk Sand Plain except for the reach between Aylmer and a point 9.6 kilometers (6 miles) downstream from Aylmer where it re-enters the Ekfrid Clay Plain.

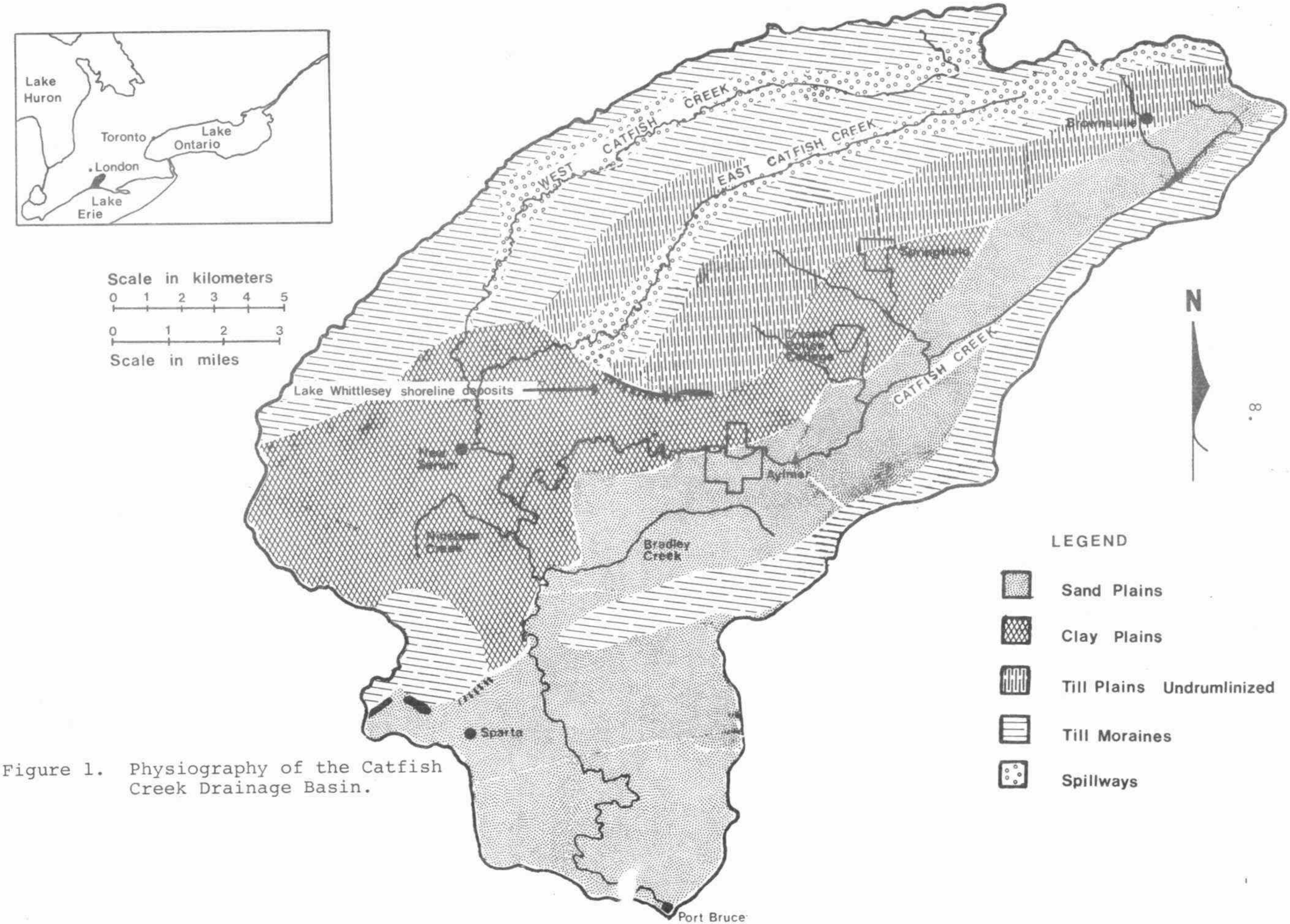

Figure 1. Physiography of the Catfish Creek Drainage Basin.

LAND AND WATER USE

Major land uses in the Catfish Creek Drainage Basin are agricultural, forest and urban.

Agricultural use predominates in the Basin. Although poorer soils characterize the southern basin, specialized crops such as flue-cured tobacco are particularly adaptable to the sandy soil conditions in this area. The general improvement in soils northward is reflected by increased mixed farming practices.

Forests flourish along water courses in the southern portion of the basin and are the Carolinian type with black walnut, tulip, sassafras, mocker nut, pig nut, bass wood and red and white oak being represented.

Urban areas within the basin include Aylmer and Springfield which had populations in 1976 of 5,025 and 555 respectively. The Townships of Yarmouth, Malahide, South Dorchester and Norwich had populations in 1976 of 8,371, 5,008, 1,788 and 9,806 respectively.

The primary water uses in the Catfish Creek Drainage Basin are irrigation, livestock watering, fishing, swimming, picnicking and waste assimilation. The Basin also provides a fish spawning habitat for several warm water species. Figure 2 shows the locations of some of the water uses and their types.

Figure 2. Water uses in the Catfish Creek Drainage Basin.

In Malahide Township, a total of 51 Permits to Take Water from Catfish Creek have been issued under the Ontario Water Resources Act. Forty-eight of these control the taking of water into storage in ponds for irrigation of tobacco crops with the remainder being used for recreational purposes. In Yarmouth Township, 14 Permits have been issued for irrigation. The majority of Permits in both cases are issued to take water from Bradley Creek, a tributary to Catfish Creek, which is surrounded by farm lands used predominantly for tobacco production.

Catfish Creek receives agricultural drainage from surrounding farmlands. Natural drainage of local soils is poor and extensive municipal and private drainage works have been constructed throughout the Basin. A number of fish kills have been attributed to farm wastes reaching the streams through these drainage works.

As a fishery, Catfish Creek is only moderately productive. Lake-run bass, channel catfish, fresh water drum, gizzard shad and alewives use the lower reaches of the stream as a spawning habitat. The Creek is, however a potential rainbow trout spawning area.

Recreation on Catfish Creek is concentrated at the Spring Water Conservation Area which is operated by the Catfish Creek Conservation Authority. At the 191 hectare (472 acre) site, a man-made lake provides fishing, swimming, camping, boating and picnicking. Such potential recreation uses as hiking, fishing and nature observations could be developed along the lower, wooded portions of the Basin.

SEWAGE TREATMENT FACILITIES

There are two sewage treatment facilities in use in the Catfish Creek Drainage Basin at the present time and a third is planned (Table 1).

The sewage treatment plant at the Ontario Police College was subject to severe hydraulic overloading due to storm water infiltration at the time of the survey. By-passing of higher flows occurred between the clarifier and the chlorine contact chamber. The average results for 20 effluent samples submitted in 1976 are presented in Appendix III. The treatment plant has recently undergone extensive renovations that will improve the effluent quality.

The waste stabilization pond system in Aylmer does not have sufficient volume to store wastes during the entire winter so that some discharge is necessary in the late winter months. Expansion of this waste treatment system is required to accommodate additional development in the Town. Effluent data for 1976 - 1978 are contained in Appendix III.

Table 1. Existing sewage treatment facilities for population centres in the Catfish Creek watershed.

Location	Responsibility	Treatment Method	Rated Capacity m^3/day - (MGD)	Remarks
Brownsville		Private sewage treatment systems		- Private waste disposal systems are now in use and no need has been demonstrated for communal sewage works except in a mobile home park near the Hamlet.
Village of Springfield	MOE Provincial Project under development (1-0328-73)	Private sewage treatment systems		- Waste loading guidelines presented in this report are intended for use by the consultant as a basis for the design of the proposed works.
Ontario Police College	Ministry of Govern- -ment Services	Extended aeration chlorination; and phosphorus removal	377 - (0.083)	- Effluent is chlorinated from May to October. - 1975 average daily flow = 118 m^3/day. - Maximum daily flow 773 m^3/day (0.170) MGD. - Approximately 700 people use the College.
Town of Aylmer	Ministry of the Environment	Waste stabilization ponds and phosphorus removal	2400 - (0.530)	- Total area 29.1 hectares (71.9 acres) - Four cells with 182 day retention. - Design population -5,000; 1976 population 5,025. - Phosphorus removal in all cells since 1977. - Insufficient volume for total winter storage.

HYDROLOGY - SURFACE WATER AVAILABILITY

GENERAL

Aside from streamflow measurements taken in the field at the time of the July 12 to 15, 1976 survey (Figure 3), all streamflow data were obtained from Federal Gauging Station 02GC018 near Sparta (Figure 4). The 10 years of record at this station (1965 to 1975) were used to pro-rate flows for sub-watershed areas in the Basin (Table 2). In general, flows are highest in March and April and lowest in August. These trends are reflected in the pro-rated data as they apply to sub-basin drainage areas. Rainfall of 0.05 centimeters (0.02 inches) and 1.4 centimeters (0.54 inches) on July 14 and 15 respectively provided an unexpected opportunity to observe the response of water quality to increased flows in the watershed.

BROWNSVILLE

Streamflows at Brownsville are highest in spring with the minimum monthly (average) flows, based on the 10 years of record, being 85 and 57 litres per second (l/sec) (3 and 2 cubic feet per second (cfs)) for March and April respectively. The drainage area above Brownsville is only 520 hectares (2 square miles) and flows may be non-existent on particular days in spring and on most days during the remainder of the year.

SPRINGFIELD

The drainage area at the junction of the two streams 0.8 kilometers (½ mile) south of Springfield is about 2070 hectares (8 square miles). The spring streamflows are the highest with the minimum monthly average flow in March being 311 l/sec (11 cfs). Streamflows will annually approach or achieve zero throughout much of the year.

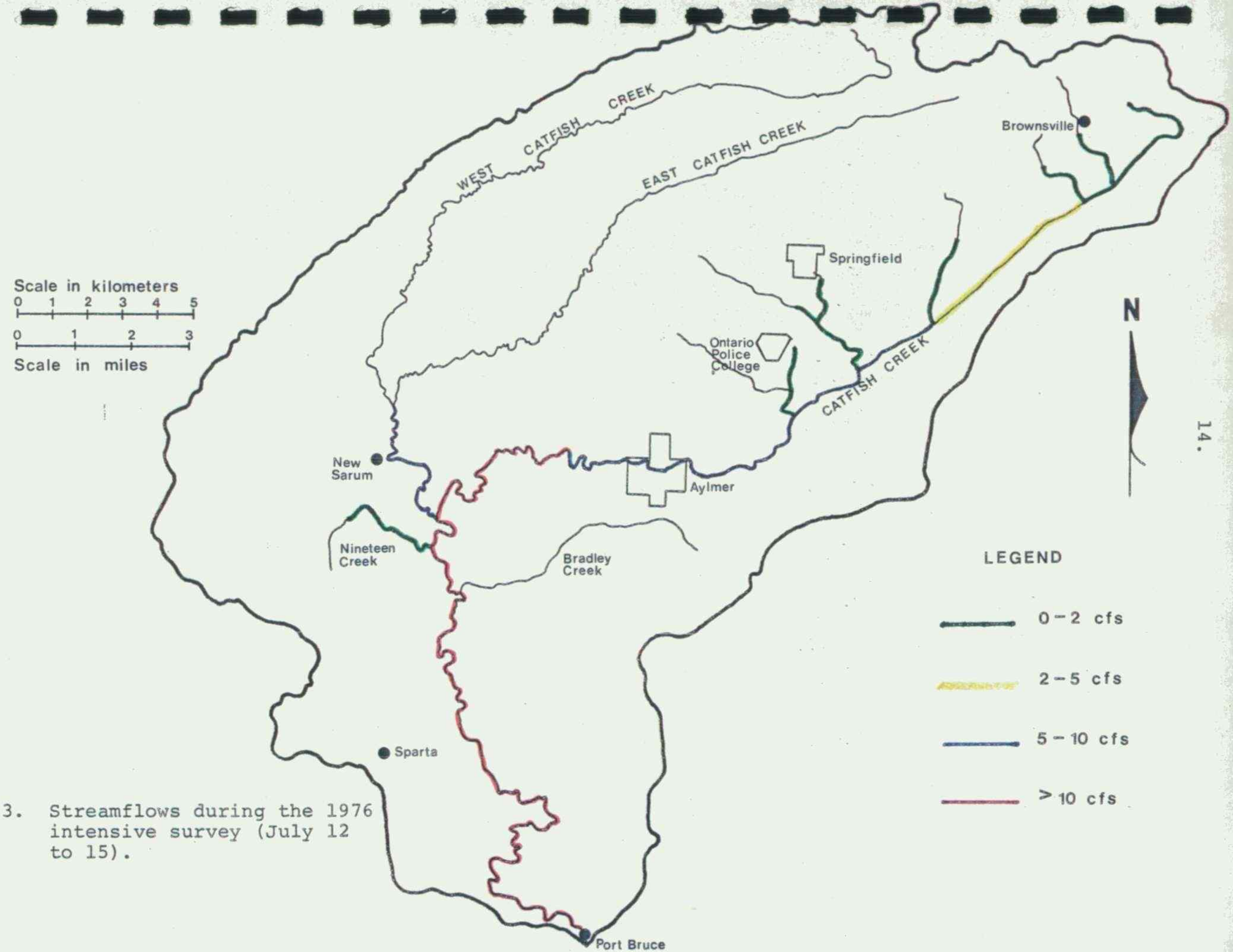

Figure 3. Streamflows during the 1976 intensive survey (July 12 to 15).

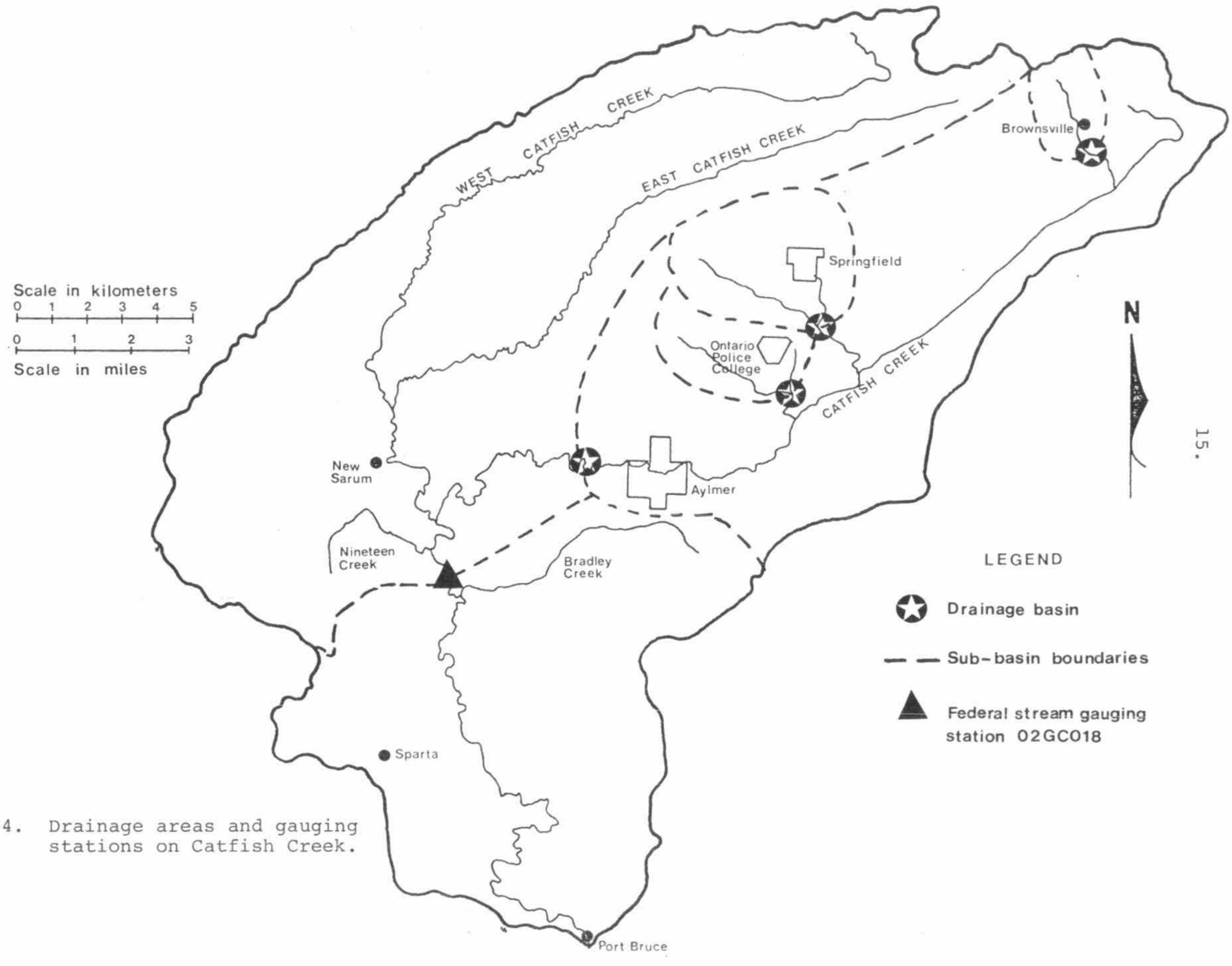

Figure 4. Drainage areas and gauging stations on Catfish Creek.

Table 2. Streamflow data from Federal Gauge 02GC018 on Catfish Creek near Sparta for the period 1965 to 1975 with pro-rated data for sub-watersheds in the Catfish Creek Drainage Basin.

Month	Federal Gauge 02GC018 on Catfish Creek near Sparta		Catfish Creek near Brownsville (Figure 4)		Catfish Creek near Springfield (Survey Station CB)***		Catfish Creek near Ontario Police College (Survey Station CC2)		Catfish Creek near Aylmer (Survey Station C6)	
	a*	b**	a	b	a	b	a	b	a	b
January	166	44	3	1	12	3	57	15	76	20
February	181	28	3	0	13	2	63	10	83	13
March	337	150	6	3	24	11	117	52	154	68
April	220	100	4	2	16	7	76	35	100	46
May	77	17	1	0	6	1	27	6	35	8
June	64	7	1	0	5	0	22	2	29	3
July	26	3	1	0	2	0	9	1	12	1
August	13	3	0	0	1	0	4	1	6	1
September	28	4	1	0	2	0	10	1	13	2
October	21	6	0	0	2	0	7	2	10	3
November	90	9	2	0	6	1	31	3	41	4
December	154	40	3	1	11	3	53	14	70	18
Drainage Area hectares (Square Miles)	28749 (111)		518 (2)		2072 (8)		9842 (38)		13209 (51)	

*a - mean monthly flow in cfs
**b - minimum monthly mean flow with a one-in-ten year recurrence interval in cfs
*** - survey stations are shown in Figure 5
Note - 1 cfs = 28.3 litres/second

ONTARIO POLICE COLLEGE

The present discharge from the sewage treatment plant at the Ontario Police College is to a small un-named tributary having a drainage area (upstream of the treatment facility) of about 520 hectares (2 square miles). The streamflows at this location are similar to those at Brownsville. The drainage area of Catfish Creek at the junction of this tributary is 9840 hectares (38 square miles). The minimum monthly average streamflows with 1-in-10 year recurrence intervals in March and April are 1472 l/sec (52 cfs) and 991 l/sec (35 cfs) respectively. Summer streamflows on the main branch of Catfish Creek also will approach or achieve zero, especially in dry years.

AYLMER

The drainage area above the discharge from the Aylmer waste stabilization ponds is 13,200 hectares (51 square miles). The minimum monthly average streamflow in March is 1924 l/sec (68 cfs). Minimum fall streamflows with a 1-in-10 year return period (4 cfs in November) are small. The pro-rated minimum, 7-day streamflow at Aylmer (Table 3) with a 1-in-10 year recurrence is 31 l/sec (1.1 cfs).

Table 3. Pro-rated minimum seven-day streamflows at Aylmer based on data from 1965 to 1975 at Federal Gauging Station 02GC018 at Sparta.

Location	Drainage Area hectares (sq. mi.)	Streamflow with a one-in-ten year Recurrence (cfs)	Streamflow with a one-in-two year Recurrence (cfs)
Federal Gauge	28749 (111)	1.4	3.5
Aylmer	13209 (51)	1.1*	2.8*

NOTE: 1 cfs = 28.3 litres/second.

* Based on spot measurements of streamflow downstream from Aylmer.

WATER QUALITY AND BIOLOGY OF CATFISH CREEK AND ITS TRIBUTARIES

GENERAL

In this section, a brief discussion and a graphical presentation of the chemical, bacteriological and biological survey results of 1976 are presented together with long-term water quality monitoring data. Survey methodology is described in Appendix I. Complete summaries of water quality data and biological taxa lists are contained in Appendix II and the biological data are presented in Table 4. Twenty stations were sampled during the 1976 survey and five, long-term stations in the basin (Figure 5) continue to be sampled monthly.

Rainfall occurred during the latter part of the survey and the effects on water quality of increased agricultural and urban runoff are included in the following discussion.

Water quality and biology in Catfish Creek are discussed in three segments: upstream from Aylmer, through Aylmer and below the Aylmer lagoons.

UPSTREAM FROM AYLMER

Water quality from Brownsville to the tributary from Springfield is fair at best. The geometric mean bacteriological levels during the survey and at the long-term station consistently exceeded this Ministry's criteria for body contact recreation, livestock watering and agri-

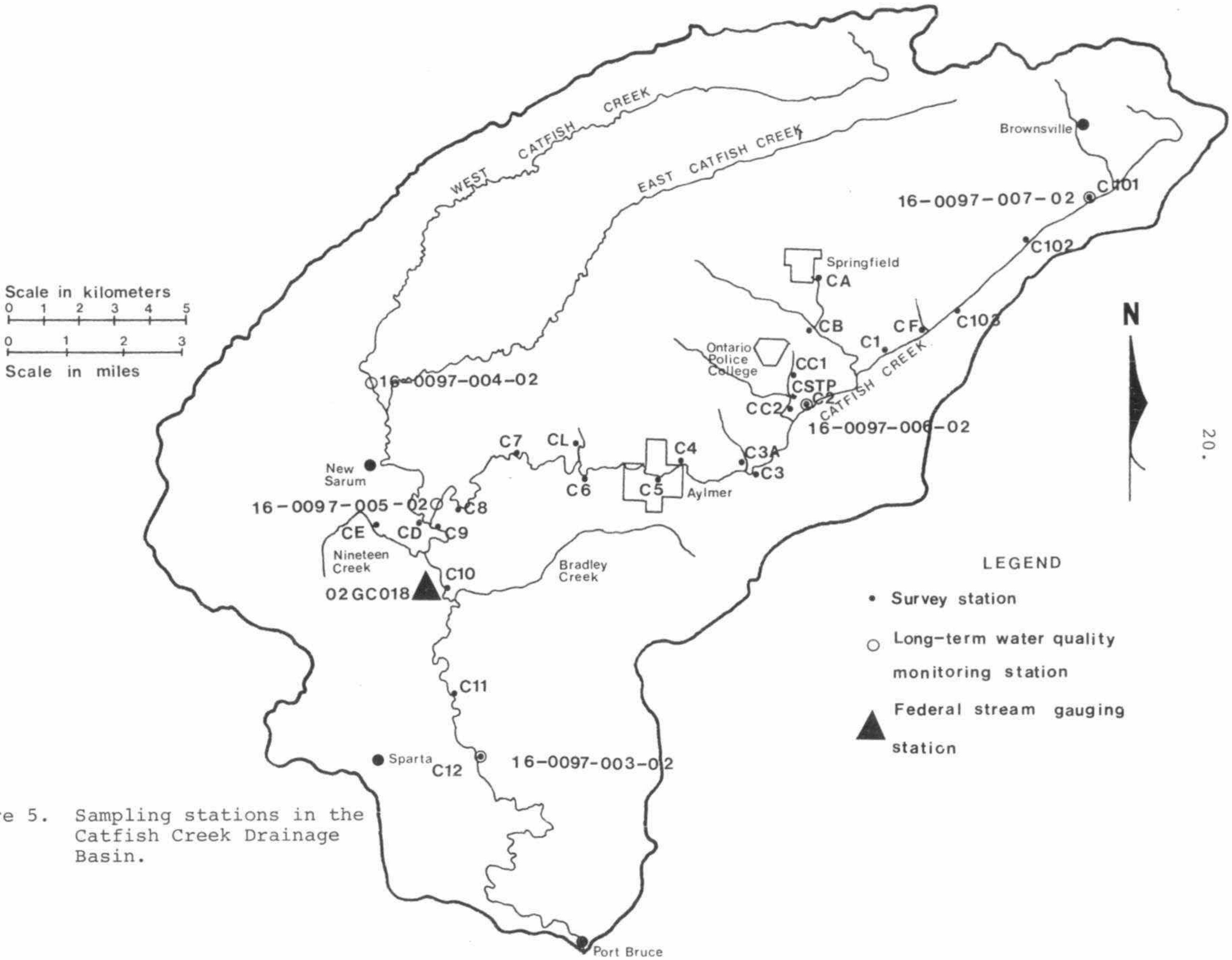

Figure 5. Sampling stations in the Catfish Creek Drainage Basin.

Table 4. Summary of 1976 biological survey data.

Station	Percent In-Stream Plant Cover		Significant Macroinvertebrates		Comments
	May and July	Sept. and Oct.	May and July	Sept. and Oct.	
C101 + C103 - on Catfish Creek downstream from Brownsville and upstream from first major tributary	0-25	0-25	caddisflies mayflies (intolerant)	caddisflies mayflies (intolerant)	- emergents and submerged rooted plants - reasonably good water quality - sandy substrates and variable flows make this reach unsuitable for intolerant species except in isolated areas.
C-1 - on Catfish Creek upstream of the Springfield tributary	0-25	0-25	mayfly (intolerant)	caddisflies (intolerant)	- isolated areas suitable for intolerant organisms - stresses preclude continuous habitation - mostly emergents and submerged rooted plants
C-A - on tributary upstream from Springfield	25-35	>90	mayfly (intolerant)	caddisflies mayflies (intolerant)	- dissolved oxygen fluctuations would cause intolerant species to seek shoreline - _Cladophora_ present
CB - at confluence of two tributaries downstream from Springfield	35-50	>90	caddisfly (intolerant)	no intolerants	- some degradation evident - _Cladophora_ present
C2 - on main branch of Catfish Creek downstream from tributary from Springfield	0-25	0-25	no intolerants	mayfly caddisfly alderfly (intolerant)	- reasonably good water quality - rooted plants present
CC2 - on tributary downstream from Ontario Police College outfall	0-25	>90	no intolerants	some intolerants	- degradation evident - _Cladophora_ present.
C-3 - on Catfish Creek upstream from Aylmer	0-25	25-50	mayflies caddisflies (intolerant)	mayflies caddisflies (intolerant)	- biological community indicates reasonably good water quality - no _Cladophora_ present

Table 4. (continued)

Station	Percent In-Stream Plant Cover May and July	Percent In-Stream Plant Cover Sept. and Oct.	Significant Macroinvertebrates May and July	Significant Macroinvertebrates Sept. and Oct.	Comments
C6 - on Catfish Creek downstream from Aylmer and upstream from the lagoon discharge	90	90	mayflies caddisflies (intolerant)	mayflies caddisflies (intolerant)	- suitable substrate provides site for *Cladophora* growths - evidence of enrichment and winter stress - biological quality reasonably good
C7 - on Catfish Creek downstream from lagoon discharge	90	80	caddisflies (intolerant)	mayflies (fewer than at C6) caddisfly larvae	- organic and nutrient enrichment and winter stress - no *Cladophora*, plant growths consisted of periphyton
C8 - on Catfish Creek downstream from Aylmer and the lagoon discharge but upstream from confluence with East and West branches of Catfish Creek	>50	>50	mayflies caddisflies (intolerant)	mayflies caddisflies (intolerant)	- large number of caddisflies reflect nutrient effects from lagoon - *Cladophora* - 80% cover in riffles
CD - on West Catfish Creek downstream from the confluence of East and West Catfish Creek	0-25	0-25	mayflies caddisflies (intolerant)	mayflies caddisflies (intolerant)	- best quality in Basin - some enrichment evident over summer since number of caddisfly larvae increased - *Cladophora* present
CE - midway on Nineteen Creek tributary	>50	-	mayflies caddisflies	-	- enriched water quality but good biological production - no flow in the fall - *Cladophora* present
C10 - on Catfish Creek at Federal Gauging Station 02GC018 and upstream of Bradley Creek	>50	0-25	mayflies caddisflies	mayflies caddisflies	- good water quality - *Cladophora* present
C11 - on Catfish Creek downstream from Bradley Creek	25-50	0-25	mayflies caddisflies (intolerant)	mayflies caddisflies (intolerant)	- good water quality - *Cladophora* present - most productive station during second sampling
C12 - on Catfish Creek downstream from C11	25-50	0-25	mayflies caddisflies (intolerant)	mayflies caddisflies (intolerant)	- good water quality - *Cladophora* present - most productive station during first sampling

cultural irrigation. Immediately following the rain which occurred during the survey, the fecal coliform and fecal streptococci counts increased by a factor of about 30 at Station C102 downstream from Brownsville. The average BOD_5, total phosphorus and total nitrogen concentrations showed no significant variation for the first two days of the survey as shown in figures 6 to 8; however all three parameters increased substantially at all stations after the rainfall commenced (figures 7 to 9 of Appendix II).

The total phosphorus concentrations throughout the upper reaches of the Basin were well above the range 0.02 to 0.06 milligrams per litre (mg/l) that is considered optimal for the growth of Cladophora and Potamogeton. The lack of a suitable substrate along with elevated turbidity and low current velocities limited growths in this region to 0 to 25 percent cover in both the spring and fall as shown in figures 9 and 10. Aquatic weed growth was limited principally to rooted aquatics such as Potamogeton (pond weed), Ceratophyllum (coontail) and Nasturtium (watercress). Where substrate and water conditions were suitable, the alga Cladophora were present. The long-term station 16-0097-007-02 at Brownsville indicates that the high phosphorus levels persist year round. High nitrate levels suggest the presence of agricultural inputs.

Biological samplings were conducted in 1976 during the May to July period and during the September to October period as shown in figures 11 and 12. The Catfish Creek Drainage Basin as far downstream as Station C-2 is more typical of an artificial drainage system than a natural stream. Intolerant organisms were poorly represented in this reach (c-1, C-2, C-101, C-103). The mayfly larvae that were present were typical of those found in heavily silted environments (Caenis, Hepteginia) or were representative of

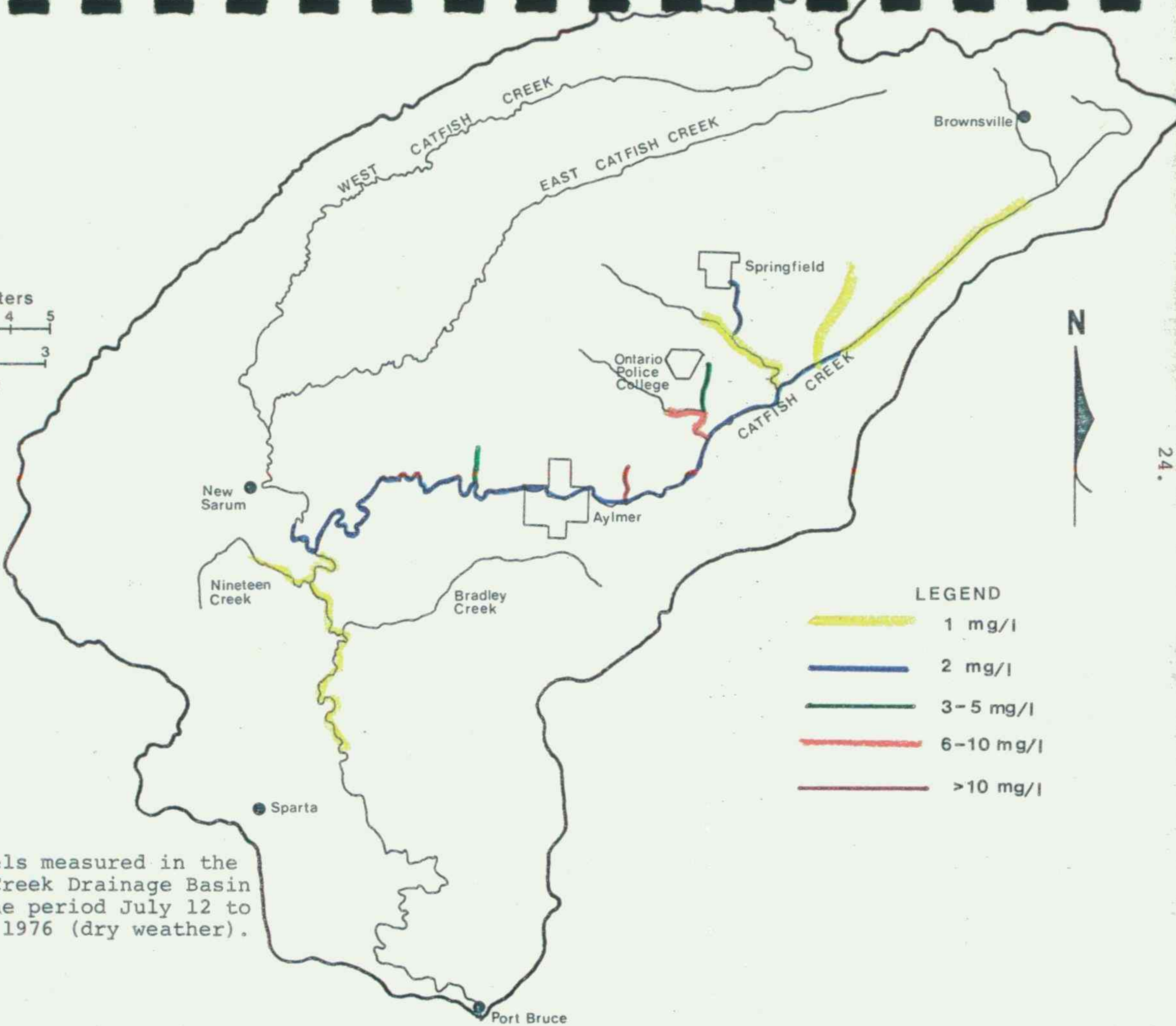

Figure 6. BOD_5 levels measured in the Catfish Creek Drainage Basin during the period July 12 to July 14, 1976 (dry weather).

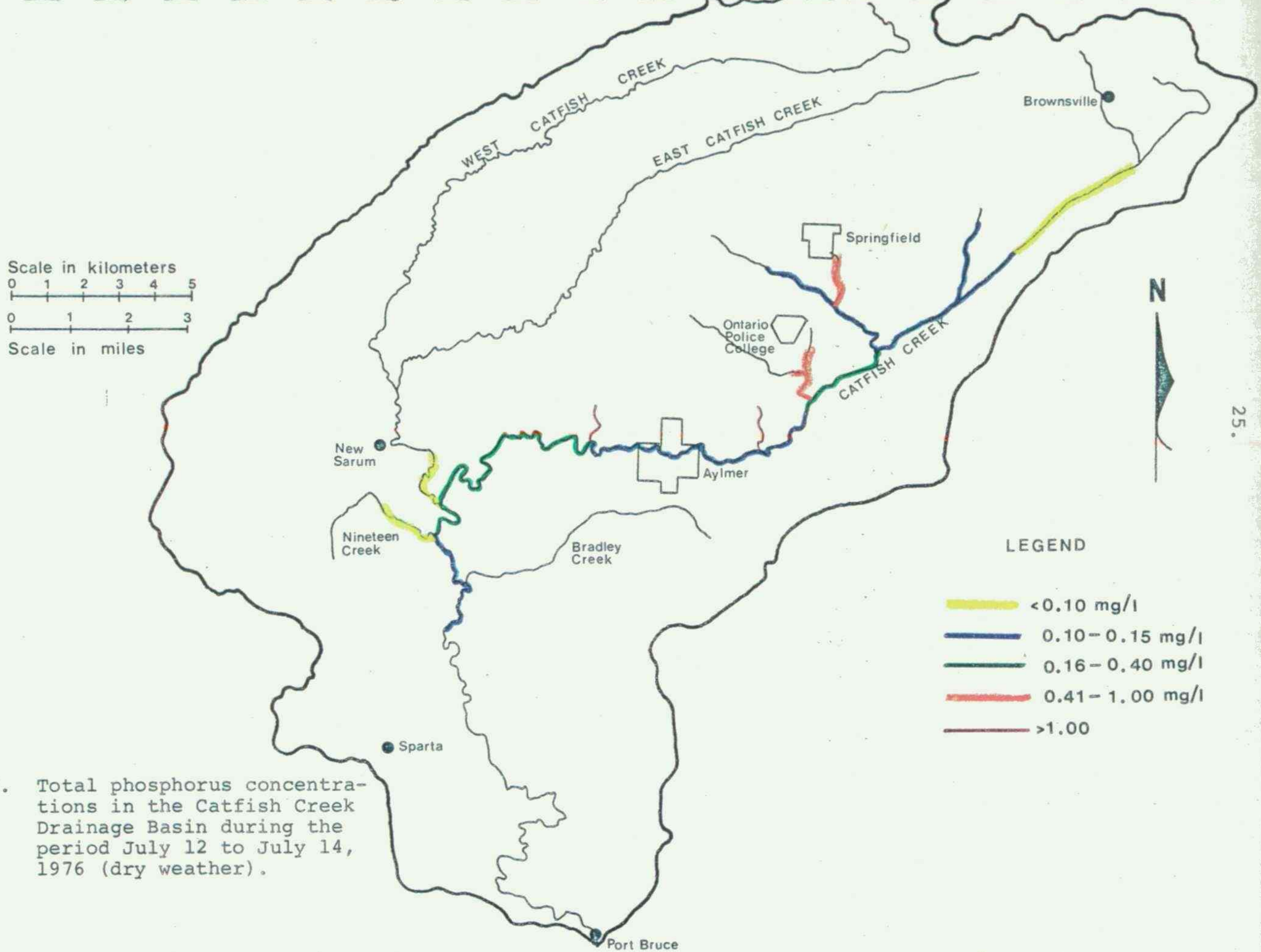

Figure 7. Total phosphorus concentrations in the Catfish Creek Drainage Basin during the period July 12 to July 14, 1976 (dry weather).

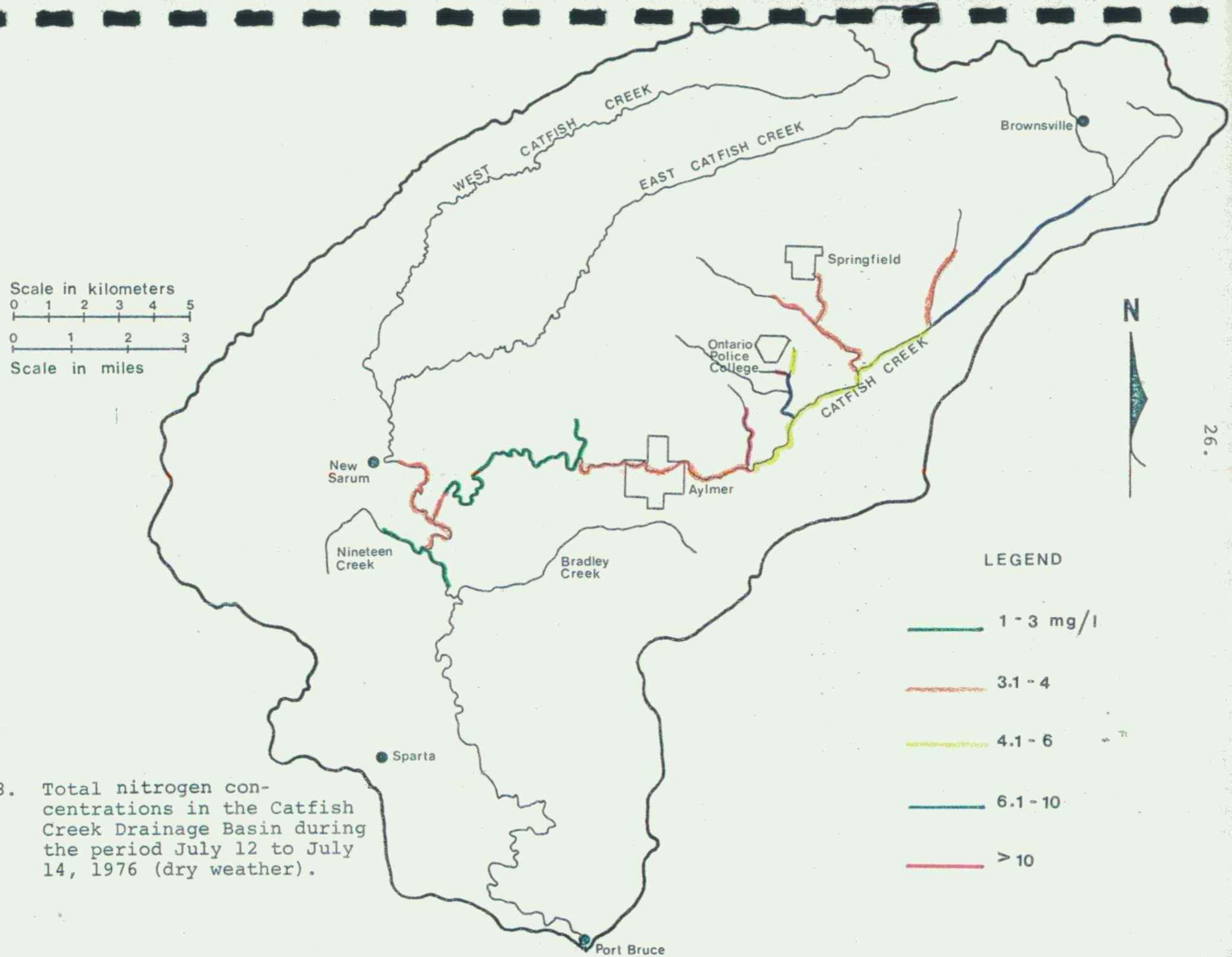

Figure 8. Total nitrogen concentrations in the Catfish Creek Drainage Basin during the period July 12 to July 14, 1976 (dry weather).

the most pollution tolerant species (Baetis). Generally, the intolerant organisms occurred infrequently in the early sampling which indicates their inability to survive the winter for whatever reasons (low flow, low dissolved oxygen, toxic conditions, etc.). Downstream from Station C-2, the stream was more natural with some bank cover, more suitable substrate and more sustained baseflow.

Tributary streams passing through Springfield and the Ontario Police College were most affected by inputs from these centres. Large diurnal dissolved oxygen fluctuations (with a minimum of 0.6 mg/l) were recorded at Springfield. Downstream of the outfall from the Ontario Police College the minimum dissolved oxygen was recorded at 2.3 mg/l. Nutrient, BOD_5 and bacterial levels were high in both tributaries probably as a result of "malfunctioning" septic tank systems in Springfield, the waterfowl area north of the Police College and from the Police College sewage treatment plant. High ratios of soluble phosphorus to total phosphorus suggest that the source is most likely septic tank effluent or inadequately treated sewage from the Police College plant. During the rainfall, levels of all parameters increased with the BOD_5 and total phosphorus at Springfield rising to maxima of 10 mg/l and 0.96 mg/l respectively. Similarily, the BOD_5, nutrients and bacteria in the sewage plant effluent became elevated during the rain. The bacterial levels at the plant following chlorination had been less than 4 colonies per 100 millilitres (ml) but rose to 420,000 fecal coliforms and 74,000 fecal streptococci per 100 ml. The effluent from the plant had a free ammonia concentration of 11 mg/l. The un-ionized ammonia concentration (0.12 mg/l) at the prevailing pH and temperature conditions was well in excess of the sublethal level for warm water biota of 0.03 mg/l.

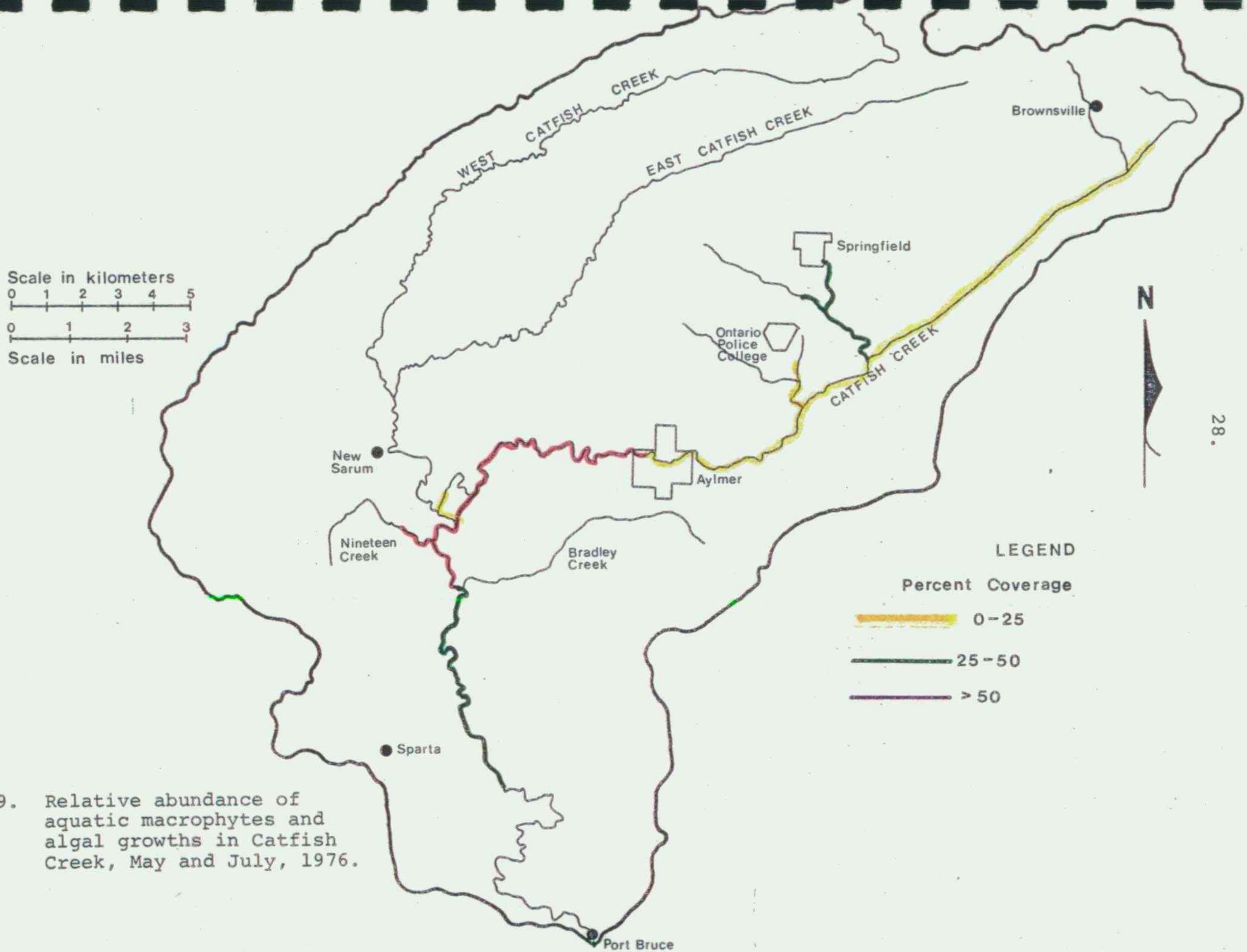

Figure 9. Relative abundance of aquatic macrophytes and algal growths in Catfish Creek, May and July, 1976.

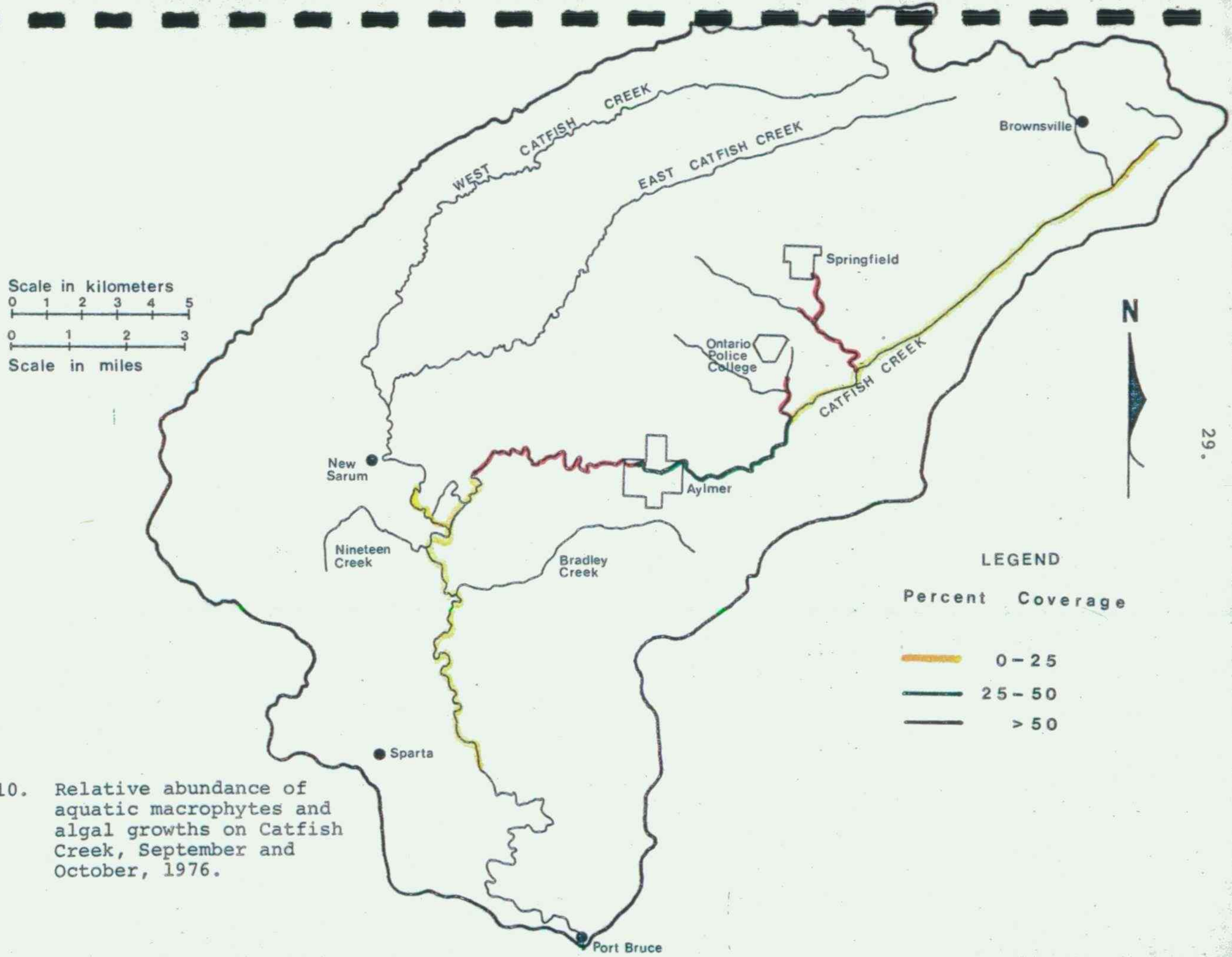

Figure 10. Relative abundance of aquatic macrophytes and algal growths on Catfish Creek, September and October, 1976.

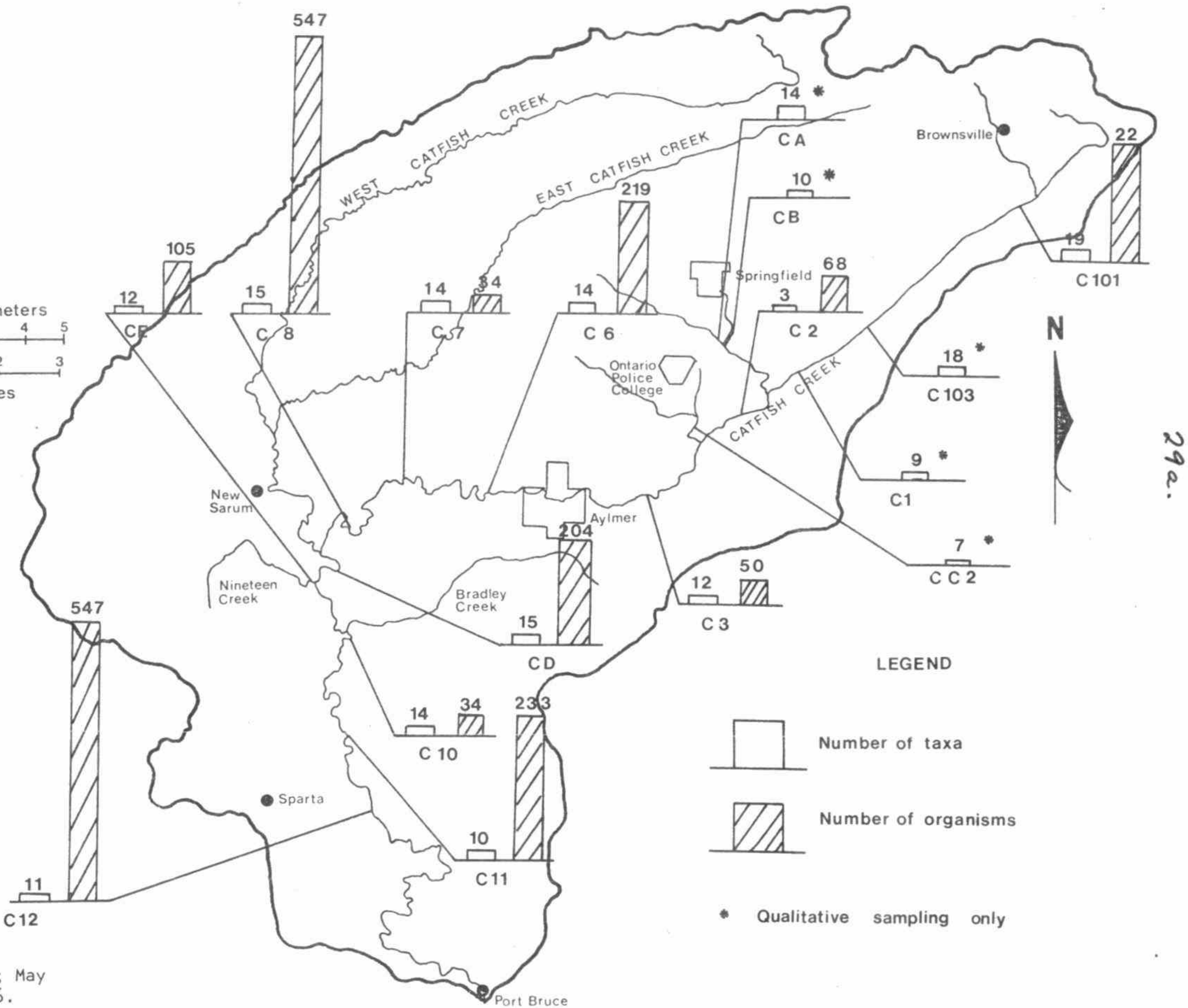

Figure 11. Total number of taxa and numbers of organisms in Catfish Creek; May and July, 1976.

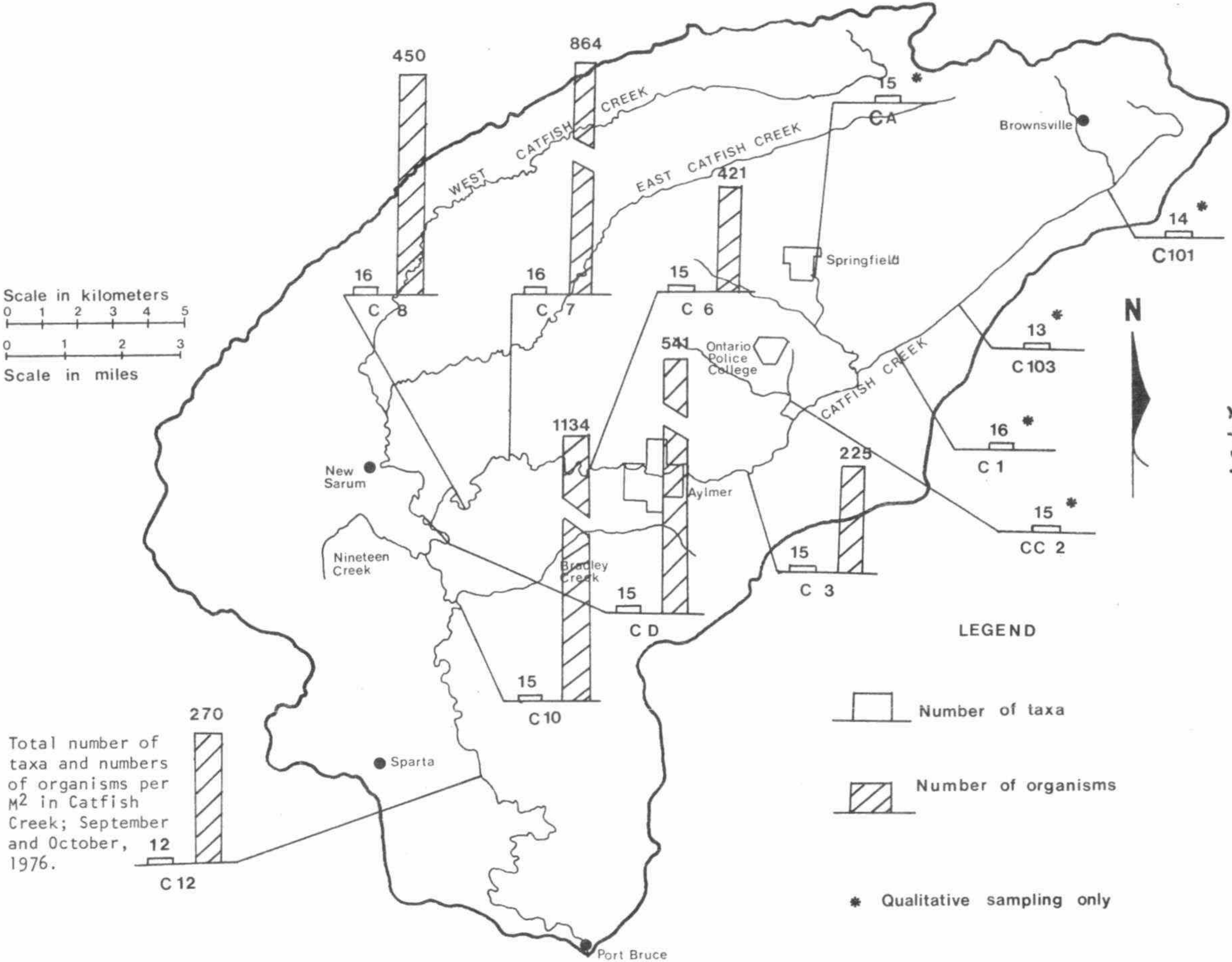

Figure 12. Total number of taxa and numbers of organisms per M^2 in Catfish Creek; September and October, 1976.

296.

Biological conditions downstream from Springfield confirm exceedance of the oxygen criterion already noted. During the spring sampling, the stream bed was covered with a new growth of the filamentous alga Cladophora. Other green algae together with bacterial slime growths (sewage fungus) indicated a constant and substantial nutrient and organic enrichment. By late fall algal growths covered 100 percent of the stream bed and had contributed to the poor oxygen conditions. Owing to sustained flows, a more balanced but facultative macroinvertebrate community was present.

Water quality on the main branch from the Springfield tributary to immediately above Aylmer showed no significant variation. Slight increases in total and soluble phosphorus, chloride and free ammonia between stations C3 and C4 (Appendix II, Table 4) may reflect the input from the small tributary upstream from Station C3A (Figure 5) or from the large storm sewer from Aylmer which discharges upstream from Station C4. Individual samples collected during the latter part of the survey, under storm conditions accentuate the inputs. The loading from the small tributary was traced to an agricultural operation upstream which has been investigated by the Industrial Abatement Section of this Ministry. The BOD_5 and nutrients at Station C3 increased slightly as a result of the rain from the last day of the survey. The bacterial levels tended to decline over this reach; possibly as a result of dilution from the chlorinated discharge from the Ontario Police College which entered the main branch via the tributary upstream from Station CC2. Data from the long-term station at Glencolin (16-0097-006-02) indicate that elevated bacterial and nutrient levels persist through the year.

At Station C3 and downstream, the physical characteristics of Catfish Creek are more typical of a natural stream as compared with upstream portions where the Creek was

typical of a drainage ditch. At Station C3, streamflows had increased, bank cover was present and the substrate, although still heavily silted, contained gravel. Intolerant macro-invertebrates appeared for the first time in quantitative samples and the numbers and variety of fish species increased. No biological data were collected at Station C4.

THROUGH AYLMER

Catfish Creek is channelized through Aylmer and was observed to be very slow moving. Heavy growths of Cladophora covered the first available substrate and reflected nutrient inputs. Discharges of storm water substantially affected chemical and bacteriological water quality during the July survey.

Biological sampling immediately downstream from Aylmer at Station C6 was almost entirely covered with the alga Cladophora in the spring (90 percent cover) and in the fall (90 percent cover). Despite the algal growths, the presence in both spring and fall of intolerant mayfly and caddisfly larvae indicated that fluctuating oxygen concentrations have not yet resulted in the loss of these intolerant species. The numbers of intolerant species (mayfly and caddisfly larvae) and individuals increased substantially from spring to fall indicating that intolerant organisms are being stressed over the winter but are recovering during the summer period.

During the first two days of the July survey, the chemical and bacteriological quality did not vary significantly. Following the rain however, the water quality deteriorated. The largest increases in concentrations were observed between stations C3 and C6 during the rain and were probably the result of inputs from storm and combined sewers from Aylmer.

For example; BOD_5 levels increased from 3 to 12 mg/l at C4, total phosphorus increased from 0.16 to 0.46 mg/l at C5, and fecal coliforms rose from 1,400 to 9,600 colonies per 100 ml at C6. The total phosphorus and total Kjeldahl nitrogen concentrations at Station C6 may reflect inputs from both urban storm water and the small tributary upstream from Station 3A since the individual samples indicated that high levels occurred at two distinct times during the period of sampling.

DOWNSTREAM FROM THE WASTE STABILIZATION PONDS AT AYLMER

The Town of Aylmer had a significant enrichment effect on Catfish Creek. During the summer months this was reflected by an increase in plant and invertebrate biomass from Station C-7 downstream.

During the survey the discharge from the Aylmer lagoons did not occur under the usual conditions. The lagoon discharge was about 4 percent of the normal spring and fall rates and streamflows were low as well. The quality of the lagoon effluent was better than during the spring and fall, 1976 discharges as presented in Appendix III. Dissolved oxygen concentrations during the survey remained above this Ministry's criterion for warm-water biota even with the documented aquatic weed growths. Phosphorus concentrations throughout the lower reach were well above the range considered critical (0.02 to 0.06 mg/l) for aquatic plant growths. Heavy growths were evident wherever a suitable substrate was available.

Low numbers of intolerant benthic invertebrates and the absence of mayfly larvae during the spring at the station immediately downstream from the discharge (C7) suggests dissolved oxygen violations during the winter months. Flows are low during the winter, thus maximizing

the effects of inputs from Aylmer. High numbers of caddisflies, (as found during the fall sampling at this station) reflect high nutrient availability and good oxygen conditions. The next two biological stations (C8 and C10) reflect a similar situation except that mayflies as well as caddisflies were present during both the spring and fall samplings indicating that the winter discharge from the Town of Aylmer were not affecting these stations as severely as Station C-7.

The long-term water quality station west of Orwell at Catfish Creek (16-0097-005-02) indicates that nutrients and bacterial levels are still high but that the levels may be due in part to discharges from the Aylmer lagoons, storm sewers in the Town or upstream inputs.

The data from East and West Catfish Creeks during the survey suggest that these tributaries contain the best water quality in the Basin at the stations sampled. At Station CD, below the confluence of the tributaries, six intolerant species were found during both the spring and fall sampling periods. Here, the average total phosphorus concentration during the survey was 0.084 mg/l and at the long-term water quality monitoring station (16-0097-004-02), upstream on west Catfish Creek, the average annual total phosphorus concentrations range from 0.282 to 0.492 mg/l. These long term averages reflect high nutrient loadings during the runoff periods and probably reflect inputs from agricultural operations. Data from Station CE indicate that Nineteen Creek also contains good water quality with some enrichment evident.

Biological conditions downstream at stations C9 through C12 continued to reflect enriched water quality. Maximum productivity of invertebrate organisms occurred through this reach during both the spring and summer sampling periods. This trend is confirmed by decreasing nutrient and bacteriological levels at stations C9 and C10.

WASTE LOADING GUIDELINES

GENERAL

The suitability of water quality for aquatic life must be maintained in the lower reaches and improved in the upper reaches of Catfish Creek. By adhering to a dissolved oxygen guideline for the protection of warm water fish species, environmental conditions will improve and the strength of the existing fishery will be upgraded. Proposed dissolved oxygen criteria are given in Table 5.

Bacterial criteria are dependent on water use and are specified in the "Guidelines and Criteria for Water Quality Management in Ontario, 1974". The permissible criteria for the following water uses are listed below:

Use	Bacteria Type	Permissible Criterion (Colonies per 100 ml.)
Livestock watering	Fecal streptococcus	40
Agricultural irrigation	Fecal coliform	100
	Fecal streptococcus	20

Since there are water takings on Catfish Creek the more restrictive criteria for agricultural irrigation has been selected for inclusion in Table 5. It should be noted that these criteria were not met at the long-term water quality monitoring stations or during the 1976 survey.

To reduce the growth of <u>Cladophora</u> and other aquatic plants identified in the streams during the surveys, the phosphorous concentrations in Catfish Creek should be reduced to 0.03 mg/l during the period May 1 to October 31.

To help achieve this, waste treatment facilities should not discharge during this period. All waste treatment systems which discharge to streams must have a continuous feed of chemical for phosphorus removal. Nutrients from urban and agricultural runoff should also be reduced.

There are several toxic chemicals commonly discharged from sewage treatment facilities that must be controlled. These include ammonia, hydrogen sulphide, phenols and total residual chlorine. The toxicity of ammonia and hydrogen sulphide is dependent on the pH and temperature. The data in Table 5 indicate the expected pH and temperature levels in Catfish Creek and the corresponding sub-lethal concentrations of free ammonia and hydrogen sulphide. These levels recognize that the un-ionized ammonia level must not exceed 0.03 mg/l and that the hydrogen sulphide concentration must not exceed 0.005 mg/l. The sublethal concentration for total residual chlorine (0.002 mg/l) is not dependent on temperature and pH.

URBAN AREAS

Brownsville

The streamflow data in Table 2 indicate that minimal flows only are available from December to April at Brownsville; however, these data have been pro-rated from the Federal Gauge at Sparta and are considered to be estimates. If private sewage treatment systems cannot continue, then a communal sewage collection and treatment system consisting of a waste stabilization pond with at least 6 months storage is recommended. Effluent should be discharged in proportion to streamflow in order to take maximum advantage of the assimilation capacity of the stream. Additional storage or treatment works may be required if the criteria in Table 5

cannot be achieved. A discharge to the main branch of Catfish Creek, where the drainage area is greater, will therefore permit a larger volume to be released. The minimum monthly mean flows with return periods of one-in-ten years should be used for design purposes.

Springfield

The drainage area at the confluence of two tributaries about 0.8 kilometers (½ mile) south of Springfield is approximately 2070 hectares (8 square miles). At least six months storage will be required at this site for any discharge to the watercourse. The discharge must be in proportion to streamflow and must not violate the water quality criteria in Table 5. Additional storage or treatment works may be required to meet the criteria.

Ontario Police College

In order to improve the water quality in the tributary stream that receives waste from the Ontario Police College the following changes must be made at the plant:

1. If the broad fluctuations in flow to the plant adversely affect the effluent which in turn impacts negatively on the stream, then the sewers should be separated to reduce infiltration of storm water into the sanitary sewers.

2. Both the BOD_5 and suspended solids levels in the discharge should be less than 15 mg/l.

3. Ammonia concentrations in the effluent and in the receiving stream should be less than the lethal concentration for warm water biota. The concentration in Catfish Creek, after mixing, must be below the sub-lethal level (Table 5).

4. The total phosphorus levels in the effluent should be less than 1 mg/l.

Table 5. Water quality criteria for Catfish Creek.

Month	Temperature 1.	pH 2.	Toxic Substances: Free Ammonia as N 3.	Toxic Substances: Hydrogen Sulphide as H_2S	Nutrients: Total Phosphorus	Dissolved Oxygen	Health Hazards 4.: Fecal Coliforms	Health Hazards 4.: Fecal Streptococci
January	0-5	7.6	5.0	0.013	1.0	6.9	-	-
February	0-5	7.6	5.0	0.013	1.0	6.9	-	-
March	10	7.8	2.1	0.025	1.0	5.3	-	-
April	15 — impossible	8.0	0.9	0.041	1.0	5(4.8)	-	-
May	20	8.3	0.3	0.088	0.03	5(4.3)	100	20
June	25	8.4	0.2	0.122	0.03	5(4)	100	20
July	25	8.3	0.2	0.098	0.03	5(4)	100	20
August	25	8.3	0.2	0.098	0.03	5(4)	100	20
September	20	8.0	0.6	0.046	0.03	5(4.3)	100	20
October	15	8.3	0.5	0.077	0.03	5(4.8)	100	20
November	10	8.3	0.7	0.067	1.0	5.3	-	-
December	5	8.0	2.0	0.031	1.0	6.0	-	-

Concentrations of free ammonia and hydrogen sulphide in the Table are laboratory values at 20°C that are equivalent to in-stream, sub-lethal levels of 0.03 mg/l unionized ammonia and 0.005 mg/l hydrogen sulphide for the stream temperature and pH conditions cited.

All values are in mg/l except temperature (°C) and pH.

Figures in brackets represent minimum instantaneous values.

1. Maximum expected temperatures.

2. Values based on seasonal variations at other stations for which pH records are available.

3. Concentrations represent sub-lethal levels at the pH and temperature values cited.

4. For the period May to October *Pseudomonas aeruginosa* should be virtually absent.

Maximum permissible concentrations for other parameters not to exceed sub-lethal conditions: a. phenols - 0.2 mg/l.
b. total residual chlorine - 0.002 mg/l.

Permissible fecal streptococcus concentration - 40 colonies per 100 ml (livestock watering criterion).

5. The minimum levels of dissolved oxygen should be 5 mg/l or more at all times.

If problems are identified in the stream as a result of the continuous discharge from the treatment plant, the wastes generated at the College should be stored from May 1 to October 31 and discharged directly into the main branch of Catfish Creek. The streamflows in the tributary to which the treatment plant now discharges are estimated in Table 2, and they appear to be insufficient to assimilate the effluent. Possible discharge alternatives for effluent from the College include: 1) transportation of the effluent to the tributary which receives Springfield's wastes for a combined discharge, 2) routing the effluent through the Ministry of Natural Resources wildfowl area near the College. Whichever alternative is adopted the criteria in Table 5 must be achieved in the receiving stream.

Aylmer

The Town of Aylmer must store its sewage for the period May 1 to October 31. A discharge in proportion to streamflow will be permitted during the remaining months provided that the criteria in Table 5 are maintained.

AGRICULTURE

Agricultural inputs to Catfish Creek and its tributaries exert a significant negative impact on water quality. Nutrient and bacteriological levels were high in reaches where the primary land use is agricultural, as indicated by the long-term water quality monitoring data as well as by information collected during the July, 1976 intensive survey. Spills and major discharges from feedlots and silage storage areas have caused fish kills over the last several years. In an effort to reduce these inputs the following recommendations are advanced:

1. Fertilizer application should be at rates recommended by the Ontario Ministry of Agriculture and Food based on soils testing.

2. Runoff from feedlots and silage storage areas should be controlled before reaching streams. Manure and liquid wastes should be applied to unfrozen ground and should be worked into the ground to ensure that wastes do not gain direct entry to the watercourse.

3. Livestock access to streams in the basin should be restricted so that direct inputs of animal wastes are reduced and erosion of stream banks is limited.

4. Adequate stream buffers along all open channels should be provided to reduce erosion and to retard overland runoff.

5. Agricultural drainage practices should be conducted in a manner to minimize soil losses including the following: various slopes along open drains depending on soil characteristics, (i.e., gradual slopes required for sandy soils), proper tile outlets, minimal disruption of vegetative cover and/or re-seeding of ditch banks following clean-out operations. Grassed waterways should be utilized whenever possible.

6. Where soil conditions permit, erosion losses should be reduced by leaving corn stubble and other crop residues on the land over fall and winter periods (i.e., spring ploughing) and minimum tillage practices should be followed.

URBAN RUNOFF

Runoff from urban areas has also been shown to have a negative impact on water quality particularly from Aylmer and Springfield. The problems in the latter municipality should be substantially reduced or eliminated with the construction of sanitary sewers.

In Aylmer, there are several combined sewers which discharge sanitary wastes to the creek during rainfall and snow melt conditions. The Town is currently proceeding with a sewer separation program as part of a long-term project. The outfalls and related areas that are contributing the most significant amounts of pollutants should be identified. The Town should then be requested to give priority to these areas respecting the sewer separation program.

Further study will be required to determine if quality control measures are required for storm water in these municipalities.

APPENDIX I

Intensive Survey Methodology

INTENSIVE SURVEY METHODOLOGY

The physical, chemical and bacteriological samples were collected during a 72-hour, round-the-clock survey from July 12 to July 15, 1976. Twenty-three stations (Figure 5) were monitored at four-hour intervals. Biological sampling was conducted on two occasions; May and July, 1976, also in September and October, 1976.

Physical

Surface water temperatures were measured using a standard, hand-held thermometer or the temperature probe of a YSI-54 RC dissolved oxygen (DO) meter. Water samples for turbidity, total solids and suspended solids (collected from just below the surface) were analysed at this Ministry's laboratory in London using standard procedures (Standard Methods, 13th Edition) or modifications of these procedures adopted by this Ministry. Streamflows were obtained from records of the Ontario Ministry of the Environment and the Water Survey of Canada. Some streamflow measurements were taken during the field investigations using an Ott current meter.

Chemical

Dissolved oxygen was measured in the field using a YSI-54 RC DO meter which was calibrated before each run against the Azide modification of the wet Winkler method. Grab samples for BOD_5, nutrients and the other chemical analyses were collected (from just below the surface) and

analysed at this Ministry's laboratory in London. Again, either Standard Methods or modifications of these methods adopted by this Ministry were used.

Bacteriology

Surface water samples were collected in 175 ml flat-sided Prince of Wales bottles every 12 hours at all stations. The samples were stored on ice and delivered to the London laboratory within 24 hours. Samples were analysed for total coliforms (TC), fecal coliforms (FC) and fecal streptococci (FS) using the membrane filtration technique (MF) described in the Standard Methods. One exception to the above was that the media used to determine FC was McConkey's membrane broth.

Biological

Depending on the characteristics of the stream substrate, bottom-dwelling invertebrates were collected employing either a Surber sampler or an Ekman dredge. Depending on the channel width, one or two samples were taken along a transect across the river, (sediment hauls from the Ekman dredge were sieved through a 24-mesh screen). Macroscopic organisms were picked from the detritus, preserved in 95 percent ethanol and returned to the laboratory for enumeration and identification. Additional organisms were collected from a variety of 'niches' at every station by duplicate 15-minute qualitative collections using a hand-held sieve.

Fish populations were assessed using a 30-foot bag seine with uniform effort at nine locations on Catfish Creek. Although most fish were identified in the field, specimens at some sites were preserved and identified at the laboratory.

Observations of aquatic weed growths and algal conditions were recorded at each station along with additional pertinent field observations.

APPENDIX II

Water Quality Data

Table 1. Numbers and species of fish collected from 9 stations on Catfish Creek - Summer 1975.

	Station Number								
	C-A	C-D	C-E	C-1	C-2	C-3	C-7	C-8	C-12
Creek chub	6	1	4	1	1				
Brook stickleback	2								
Common shiner	5	5	50	9	2	11	23	24	
White sucker	5	5	4		2	6	4	14	3
Bluntnose minnow	21	9	50	40	30	9	1	3	
Fathead minnow	1				1				
Johnny darter	1	2	4						1
Smallmouth bass		3	1					4	2
Stonecat					1				
Rock bass		1						2	
Rosyface shiner								3	
Freshwater drum								2	2
Blackside darter								1	
Yellow bullhead								1	
Carp									1
Total Taxa	7	7	6	3	7	3	3	9	5
Total Number Present	41	26	113	50	38	26	28	54	9

Table 2. Macroinvertebrates collected at 16 stations on Catfish Creek - May and July, 1976.

(Numbers per square foot)

Organisms		*	*			*										
	C-1	C-2	C-3	C-A	C-B	C-101	C-103	CC-2	C-6	C-7	C-8	C-D	C-E	C-10	C-11	C-12
MAYFLIES																
Baetis	P											1	4	P	P	P
Caenis			P			P	P								P	
Hexagenia limbata												P				
Neocloeon			P													
Paraleptophlebia				P												
Stenonema interpunctatum									4		11	P	P	P	P	
S. tripunctatum			P									P	P			
CADDISFLIES																
Cheumatopsyche						2	P		5	5	145	50	8	P	P	8
Hydropsyche			7		P				7	21	70	30		1		4
Polycentropus											1					
DAMSELFLIES																
Coenagrionidae	P			P	P	P	P		P	P	P	P	P	P		
Agrionidae				P						P		P	P	P		
DRAGONFLIES																
Aeschnidae			P													
Plathemis lydia				P	P											
TRUE BUGS																
Corixidae	P	P	P		P	P	P			P						
BEETLES																
Dytiscidae						P							P	1	P	P
Elmidae				P			P		2	5	5	13	P	1		2
Gyrinidae						2										
Haliplidae						2	P									
Helodidae							P									
Hydrophilidae						P										
Adults (unident.)	P			P		2	P	P	4	P	24	16	6	2	P	3

Table 2 - continued ......

	C-1	* C-2	* C-3	C-A	C-B	* C-101	C-103	CC-2	C-6	C-7	C-8	C-D	C-E	C-10	C-11	C-12
TRUE FLIES																
Simuliidae						P	P				1		13		5	321
Empididae											2			20		
Chironomidae	P		32	P	P	141	P	P	163	21	259	79	73	9	228	200
Chaoborinae									7	1						
Tabanidae																1
unident. pupae	P	68	5	P	P	9	P	P	8	2	6	2				2
AQUATIC BUTTERFLIES																
Synclita									2							
Parargyractis										1	1	2				
AMPHIPODS																
Crangonyx				P	P			P		P						
Gammarus															P	P
Hyalella azteca	P		P	P	P	P	P	P	1	P	1	1		P		
ISOPODS																
Asellus						P	P					P		P	P	
Lirceus		P														
CRAYFISH																
Orconectes propinguus						P										
O. immature						P	P									
SNAILS																
Gyraulus			2	P	P											
Helisoma						P	P									

Table 2. - continued ......

Organisms	C-1	* C-2	* C-3	C-A	C-B	* C-101	C-103	CC-2	C-6	C-7	C-8	C-D	C-E	C-10	C-11	C-12
<u>Physa</u>	P		P	P		P	P	P	5	P	1					
<u>Lymnaea</u>	P					P										
CLAMS																
<u>Pisidium</u>				P		2	P	P	1							
<u>Sphaerium</u>						3			4		11	2		P		
Unionidae			2				P									
MITES						P				4	2					
LEECHES				P	P		P		1				P			
FLATWORMS				P			P				7	8		P		1
WORMS																
Tubificidae	P		2	P	P	65		P	5	P			1		P	6
No. Taxa	9	3	12	14	10	19	18	7	14	14	15	15	12	14	10	11
No. Organisms	-	68	50	-	-	228	-	-	219	60	547	204	105	34	233	548

* Ekman Dredge Samples; P - Qualitative Sampling

Table 3. Macroinvertebrates collected at 16 stations on Catfish Creek - September and October, 1976.

(Numbers per square foot)

Organisms	C-1	*C-2	C-3	C-A	C-B	C-101	C-103	CC-2	C-6	C-7	C-8	C-D	C-E	C-10	C-11	C-12
MAYFLIES					N								N		D	
Baetis				P	O			P	50	106	35	15	O	50	I	36
Callibaetis															S	P
Caenis							P		1						C	
Heptagenia		P	P		F	P							F		O	
Stenonema canadense			23		L							P	L		N	
Stenonema tripunctatum				P	O							P	O		T	
Stenonema (unidentified)			P	P	W				11	2		3	W	1	U	P
															E	
CADDISFLIES															D	
Cheumatopsyche	P	P	82	P			P		36	239	78	320		490		60
Hydropsyche	P		62						45	367	250	160		738		143
Hydroptila										1						
Phryganea			P			P	P	P								
ALDERFLIES																
Sialis		P														
DAMSELFLIES																
Agrionidae	P	P	P				P				P			P		
Coenagrionidae				P				P	P	P	P	P				P
Amphiagrion saucium	P					P	P									
DRAGONFLIES																
Gomphus	P	P														
TRUE BUGS																
Corizidae		P	P	P		P	P	P		P		P		P		
Notonectidae				P				P								
Belostomatidae	P	P				P	P			P	P			P		
Nepidae	P						P									

Table 3 - continued .....

Organisms	C-1	* C-2	C-3	C-A	C-B	C-101	C-103	CC-2	C-6	C-7	C-8	C-D	C-E	C-10	C-11	C-12
BEETLES																
Psephenidae											1					
Dytisidae				P				P	P							
Elmidae			2							32	11	2		7		
Haliplidae				P												
Hydrophilidae								P								
Adults (unident.)	P	P	18	P		P	P	P	1	14	29	11		10		1
TRUE FLIES																
Simuliidae				P					36	8	3	20		6		4
Chironomidae	P	75	37	P		P	P	P	22	12	21	3		27		22
Tabanidae	P						P									
Tipulidae		P														
Tubifera								P								
(unident. pupae)			P											5		3
AMPHIPODS																
Hyalella azteca	P	P	P	P		P	P	P	1	P	P			P		1
ISOPODS																
Asellus								P				P		P		P
CRAYFISH																
Orconectes propinguus	P		1											P		
SNAILS																
Gyraulus		P		P				P								
Helisoma						P										
Physa	P	P	P	P		P	P	P	3	P	P	1		P		

Table 3. - continued .....

Organisms	C-1	* C-2	C-3	C-A	B	C-101	C-103	CC-2	C-6	C-7	C-8	C-D	C-E	C-10	C-11	C-12
<u>Lymnaea</u>								P								
<u>Planorbidae</u>						P										
<u>Ferrissia</u>											1					
CLAMS																
<u>Pisidium</u>		P				P		P	8			1				
<u>Sphaerium</u>	P	P	P						3	58	2			1		
<u>Unionidae</u>																
LEECHES		P		P						1						
FLATWORMS	P	P	P			P		P	1	1	2	4				
WORMS																
Tubificidae	P	7	P	P		P		P	3	23	17	1				P
No. Taxa	16	18	15	15	-	14	13	17	15	16	16	15	-	15	-	12
No.Organisms	-	82	225	-	-	-	-	-	221	864	450	541	-	1134	-	270

*Ekman Dredge Samples; P- Qualitative Sampling

Table 4. Water quality data from the July 12-15, 1976 intensive survey on Catfish Creek.

Station	Dissolved Oxygen			C^o	BOD_5			Phosphorus				Nitrogen					
								Total					Kjel				
	Ave	Max	Min	Temp	Ave	Max	Min	Ave	Max	Min	Sol	FA	Ave	Max	Min	NO_2	NO_3
C-101	7.5	19.2	5.4	17.5	2	9	0	0.259	2.00	0.060	0.046	0.045	1.155	6.35	0.49	0.142	7.5
C-102	9.5	18.5	6.2	18.2	2	11	0	0.294	1.81	0.042	0.045	0.042	0.731	6.75	0.43	0.118	6.1
C-103	8.6	13.6	6.1	17.5	2	4	1	0.154	0.46	0.080	0.027	0.040	1.017	1.75	0.71	0.111	5.3
C-F	9.6	16.2	5.0	18.9	2	4	0	0.113	0.298	0.074	0.027	0.016	0.678	0.950	0.404	0.084	3.3
C-1	8.6	12.0	5.7	19.1	2	5	1	0.152	0.43	0.072	0.027	0.029	0.948	1.45	0.710	0.112	4.4
C-A	9.7	>20	1.6	19.6	4	10	1	0.538	0.96	0.5	0.405	0.114	0.907	2.8	0.40	0.404	3.3
C-B	9.2	19.4	5.3	19.3	2	4	0	0.148	0.70	0.048	0.028	0.054	0.988	1.7	0.65	0.151	2.4
C-2	9.1	13.7	5.8	18.6	2	5	1	0.186	0.96	0.074	0.026	0.017	0.847	1.35	0.66	0.069	3.9
C-C-1	8.4	11.8	6.0	19.1	6	10	1	0.468	0.70	0.28	0.068	0.144	2.269	3.80	0.75	0.088	1.2
C-STP	7.4	10.8	4.0	17.9	14	41	3	0.988	2.10	0.455	0.182	1.03	14.8	20.2	1.45	0.256	2.3
C-C-2	6.2	12.4	2.3	18.7	9	17	3	0.586	4.2	0.13	0.237	0.741	3.75	7.3	0.880	0.275	5.3
C-3	8.6	11.8	6.4	19.5	4	8	1	0.144	0.24	0.080	0.025	0.027	0.858	2.10	0.30	0.067	3.8

Abbreviations: Ave - average; TC- total coliforms; Sol - soluble

Max - maximum; FC- fecal coliform; Kjel - total Kjeldahl nitrogen

Min - minimum; FS - fecal streptococcus; NO_2 - nitrite

Temp - temperature; PA-Pseudomonas aeruginosa; NO_3 - nitrate

BOD_5-Biochemical Oxygen Demand; Susp. - suspended

Table 4. - continued

Station	Bacteria /100 ml				Solids		Conductivity	Chloride	Turbidity	pH
	T C	F C	F S	P A	Total	Susp				
C-101	5133	892	522		648	215	650	20.7	109	7.88
C-102	14362	1368	1294		642	192	619	19.4	120	7.95
C-103	4174	1460	419		501	54	624	18.3	42	8.03
C-F	4026	880	815		431	30	587	15.2	14	8.06
C-1	8857	1565	745		492	58	597	16.5	34	8.01
C-A	212,635	2848	3715		469	12	673	56.0	6.1	8.42
C-B	4660	2159	509		457	33	593	77.4	39	8.20
C-2	23,466	1764	711		484	55	601	17.6	22	8.05
C-C-1	7544	3413	1673		528	189	462	20.2	137	7.79
C-STP	164	75	60		658	38	761	49.9	30	7.46
C-C-2	10748	904	853		530	37	619	34.9	30	7.78
C-3	15428	1337	731		482	53	600	19.4	25	8.11

Table 4. - continued

Station	Dissolved Oxygen Ave	Dissolved Oxygen Max	Dissolved Oxygen Min	C° Temp	BOD_5 Ave	BOD_5 Max	BOD_5 Min	Phosphorus Total Ave	Phosphorus Total Max	Phosphorus Total Min	Phosphorus Sol	Nitrogen FA	Nitrogen kjel Ave	Nitrogen kjel Max	Nitrogen kjel Min	Nitrogen NO_2	Nitrogen NO_3
C-3A	1.9	5.8	0.8	19.3	114	235	4	1.426	2.3	0.32	0.290	25.15	35.52	79.5	1.60	0.260	3.5
C-4	8.9	13.1	5.8	19.5	3	12	1	0.065	0.330	0.094	0.040	0.049	0.859	1.6	0.60	0.071	3.1
C-5	8.9	13.5	5.8	20.4	4	10	1	0.157	0.46	0.098	0.048	0.276	1.091	1.45	0.655	0.192	2.8
C-6	9.2	15.5	5.3	20.8	3	8	1	0.156	0.326	0.093	0.063	0.064	0.839	1.20	0.520	0.150	2.7
C-L	8.2	11.5	7.0	19.8	4	7	2	2.69	3.05	2.20	1.86	0.165	1.56	2.40	1.05	0.261	0.52
C-7	9.2	13.1	5.2	21.0	3	5	0	0.272	0.36	0.234	0.162	0.023	0.779	1.12	0.500	0.044	2.1
C-8	9.3	14.7	5.7	21.4	2	5	1	0.249	0.378	0.190	0.144	0.015	0.798	0.960	0.590	0.021	2.0
C-D	8.9	12.5	6.8	20.1	2	3	1	0.084	0.25	0.057	0.018	0.031	0.658	1.00	0.485	0.036	3.3
C-9	8.8	12.3	6.3	20.3	2	3	0	0.180	0.226	0.080	0.097	0.020	0.755	1.00	0.630	0.023	2.2
C-E	10.0	16.6	6.4	20.3	1	3	0	0.078	0.110	0.033	0.028	0.028	0.614	0.830	0.280	0.030	1.3
C-10	10.5	15.3	6.2	21.3	2	3	1	0.143	0.182	0.113	0.066	0.024	0.714	0.980	0.450	0.021	1.8

Table 4. - continued

Station	Bacteria /100 ml				Solids		Conductivity	Chloride	Turbidity	pH
	T C	F C	F S	P A	Total	Susp				
C-3A	122,107	5367	79063		493	63	1130	103	29	7.52
C-4	8,870	883	751		491	51	609	29.2	24	8.14
C-5	9,671	690	717		481	40	614	26.5	22	8.14
C-6	15,925	1394	859		476	41	602	24.6	21	8.22
C-L	276	66	35		568	10	898	104	3	8.24
C-7	5,694	884	419		492	68	611	30.5	23	8.34
C-8	4,480	722	394		485	45	618	30.2	23	8.42
C-D	980	388	217		460	36	613	28.9	23	8.12
C-9	1,901	308	214		473	36	613	28.8	19	8.32
C-E	2,690	504	293		440	24	611	53.6	15	8.13
C-10	615	176	140		457	30	602	28.5	16	8.40

Table 5. Water quality data at long-term water quality monitoring stations in the Catfish Creek Drainage Basin.

Station	Dissolved Oxygen			C° Temp	BOD_5			Phosphorus Total			Phosphorus	Nitrogen	Nitrogen kjel			Nitrogen	
	Ave	Max	Min		Ave	Max	Min	Ave	Max	Min	Sol	FA	Ave	Max	Min	NO_2	NO_3
16-0097-003-02	Concession Road 2 Miles East of Sparta																
1975					3	7	1	0.41	1.62	.116	0.10	0.11	1.3	4.30	.575	0.05	2.3
1976					3	5	1	0.23	.66	.075	0.072	0.080	0.97	2.48	.600	0.07	3.1
1977					3	8	6	0.426	2.00	.052	0.123	0.270	1.44	3.73	.57	0.035	2.5
16-0097-004-02	West Catfish Creek - First Concession North of Hwy. 3																
1975					3	5	1	0.144	.234	.062	0.036	0.071	1.08	1.69	.940	0.041	3.3
1976					3	4	1	0.156	.430	.038	0.042	0.083	0.89	1.42	.515	0.07	5.0
1977					3	7	1	0.213	.5	.034	0.086	0.289	1.41	2.9	.445	0.041	3.5
16-0097-005-02	Hwy. 3, 1/2 Mile West of Orwell																
1975					3	5	1	0.282	.470	.129	0.127	0.074	1.16	2.15	.725	0.044	3.34
1976					3	6	1	0.381	.820	.081	0.196	0.602	2.12	2.50	.655	0.071	3.8
1977					3	11	1	0.492	.84	.140	0.275	0.454	1.67	3.9	.620	0.053	2.74

Table 5 - continued

Station	Dissolved Oxygen Ave	Dissolved Oxygen Max	Dissolved Oxygen Min	C° Temp	BOD5 Ave	BOD5 Max	BOD5 Min	Phosphorus Total Ave	Phosphorus Total Max	Phosphorus Total Min	Phosphorus Sol	Nitrogen FA	Nitrogen Kjel Ave	Nitrogen Kjel Max	Nitrogen Kjel Min	Nitrogen NO_2	Nitrogen NO_3
16-0097-006-02	Elgin County Road 40 - Glencolin																
1976					2	4	1	0.284	.670	.081	0.093	0.308	1.22	2.28	.665	0.045	3.7
1977					2	10	1	0.216	.750	.040	0.106	0.270	1.21	3.95	.483	0.050	3.17
16-0097-007-02	On Oxford County Road 10, 1 mile south of Brownsville																
1976					4	7	2	0.381	1.0	.09	0.053	0.207	1.915	3.68	.615	0.052	3.19
1977					2	6	1	0.110	.34	.046	0.035	0.158	0.878	1.9	.565	0.043	3.46

Table 5 - continued

Station	Bacteria /100 ml				Solids		Conductivity	Turbidity	Chloride
	T C	F C	F S	P A	Total	Susp			
16-0097-003-02									
1975	11088	811	679	-	599	242	514	123	20
1976	2842	145	168	3	450	71	574	49	32.3
1977	2493	220	298	2	548	210	496	107	22.4
16-0097-004-02									
1975	6896	832	1088	7			605	46	23
1976	4095	363	514	2	467	55	591	51	28
1977	2786	415	326	2	480	131	478	96	26.7
16-0097-005-02									
1975	15152	1573	2766	6			655	44	30.9
1976	11280	592	432	6			645	37	33.5
1977	6316	378	450	4			590	12	64.7

Table 5 - continued

Station	Bacteria /100 ml				Solids		Conductivity	Turbidity	Chloride
	TC	FC	FS	PA	Total	Susp			
16-0097-006-02									
1976	33856	686	507	-	502	54	693	45	34.5
1977	1755	123	110	2	428	37.9	553	35	19.4
16-0097-007-02									
1976	17248	785	613	-	478	63	655	33.2	22.8
1977	3535	514	372	2	405	26.8	586	14.3	17.3

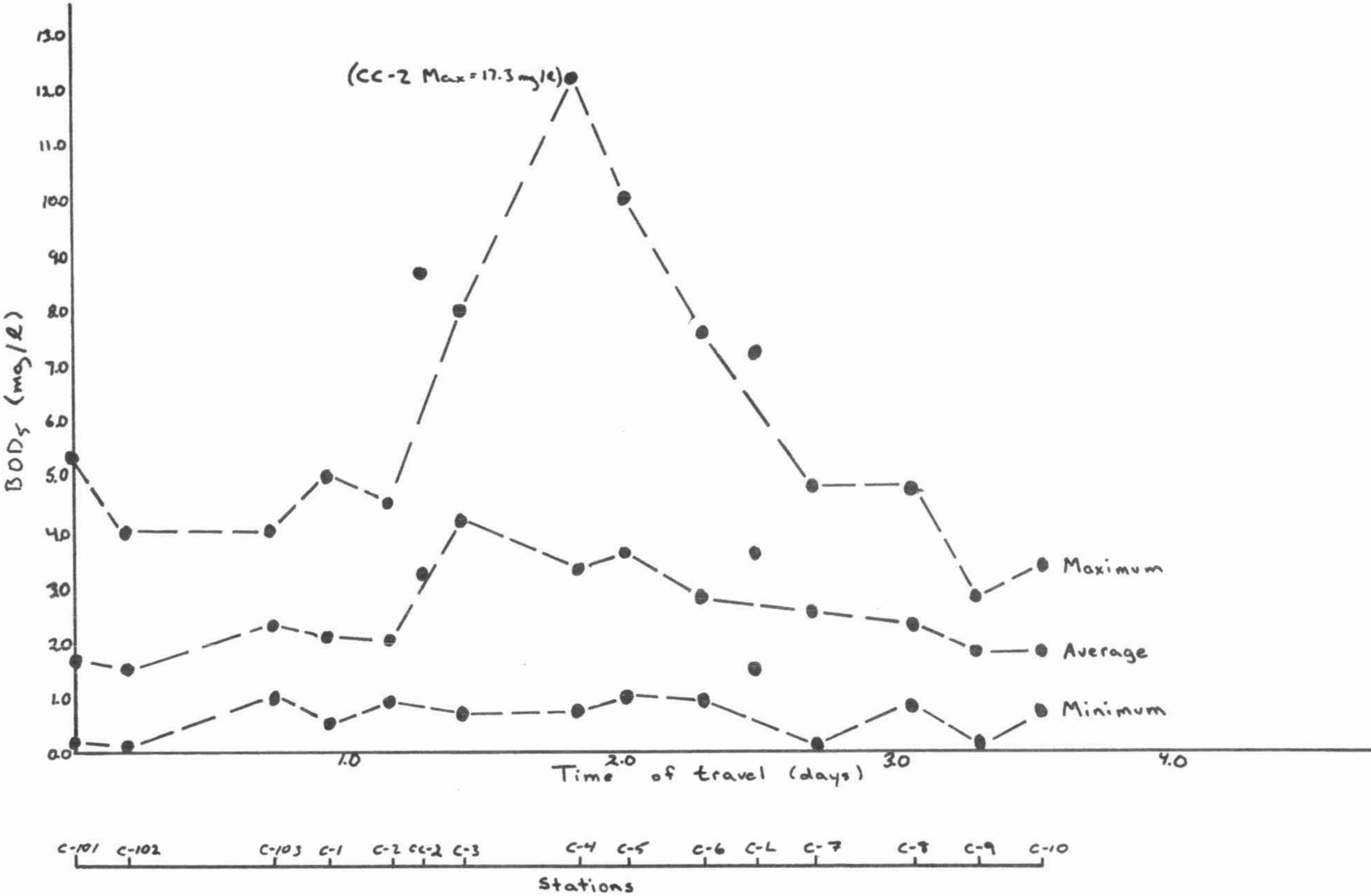

Figure 1. BOD_5 vs time of travel for stations on Catfish Creek July 12-15, 1976.

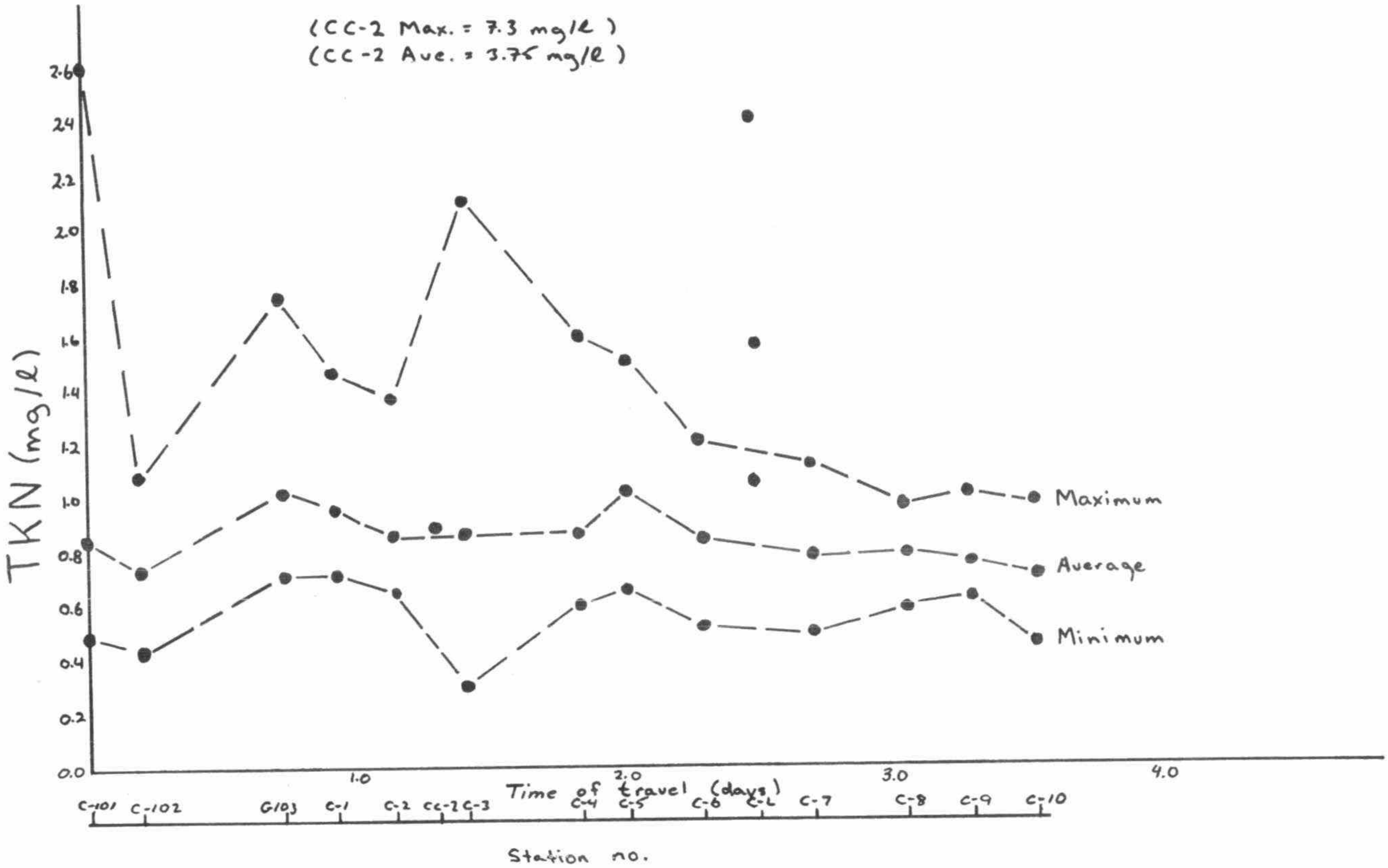

Figure 2. TKN vs time of travel for stations on Catfish Creek July 12-15, 1976.

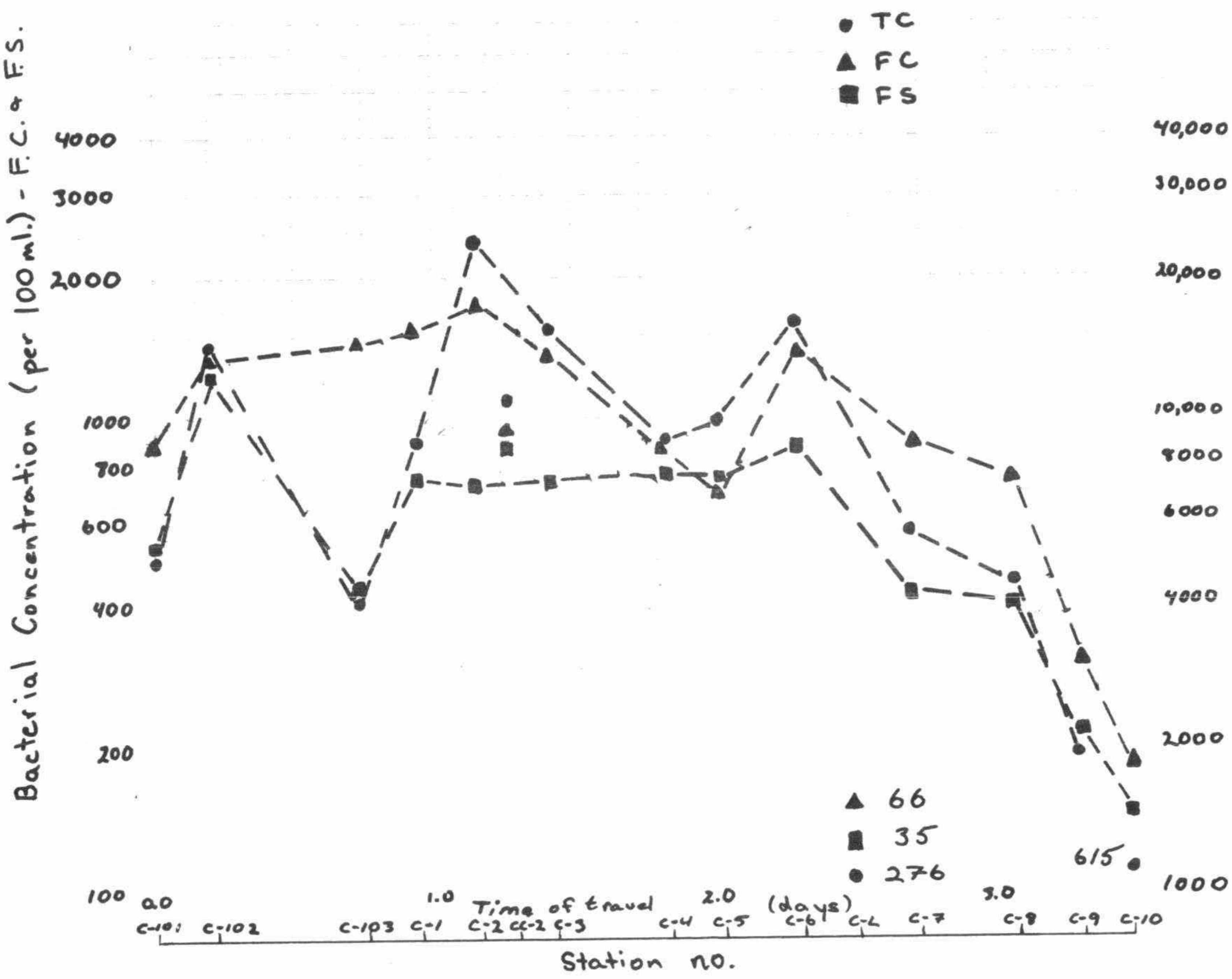

Figure 3. Bacteria vs time of travel for stations on Catfish Creek, July 12-15, 1976.

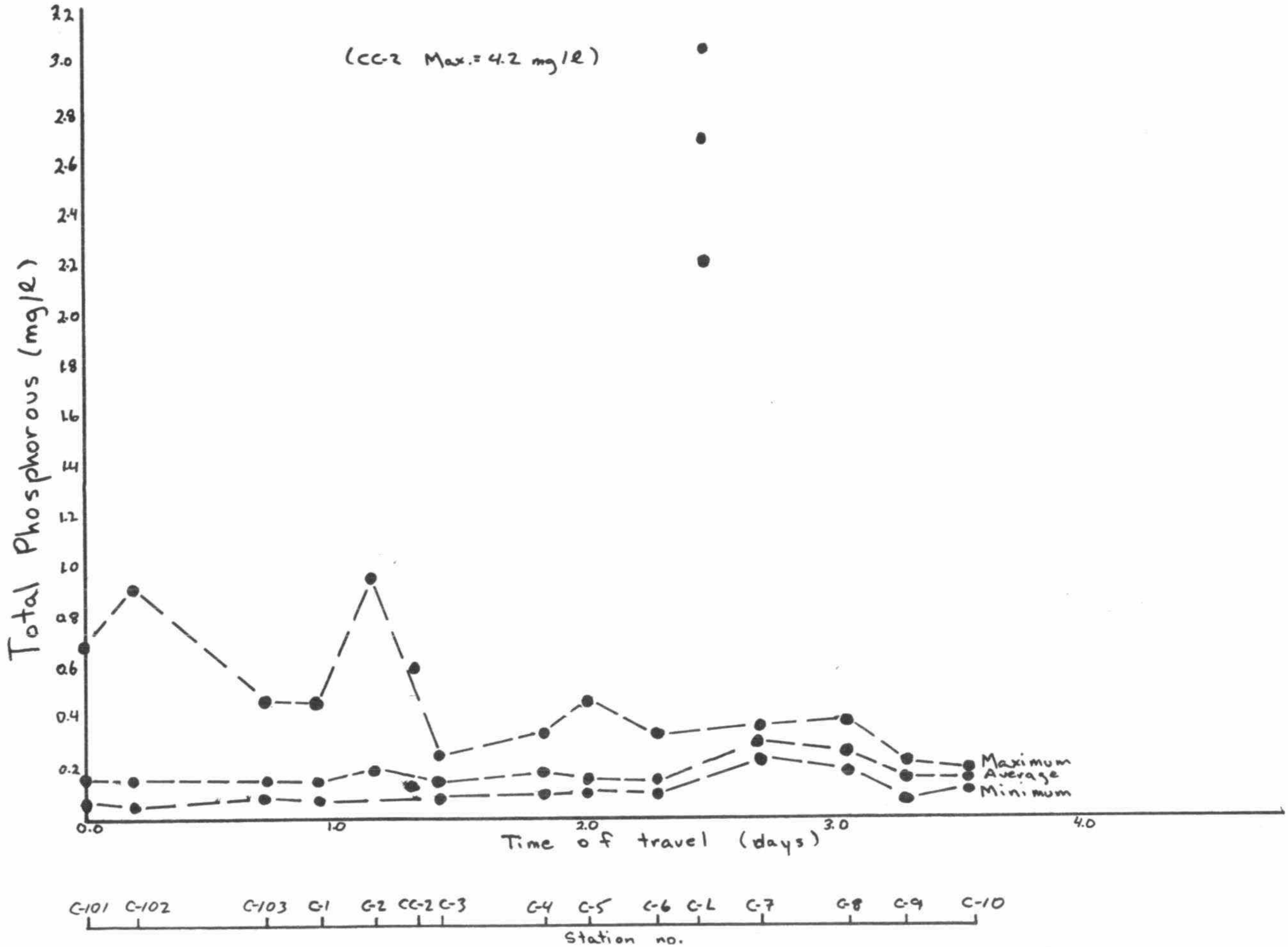

Figure 4. Total phosphorus vs time of travel for stations on Catfish Creek, July 12-15, 1976.

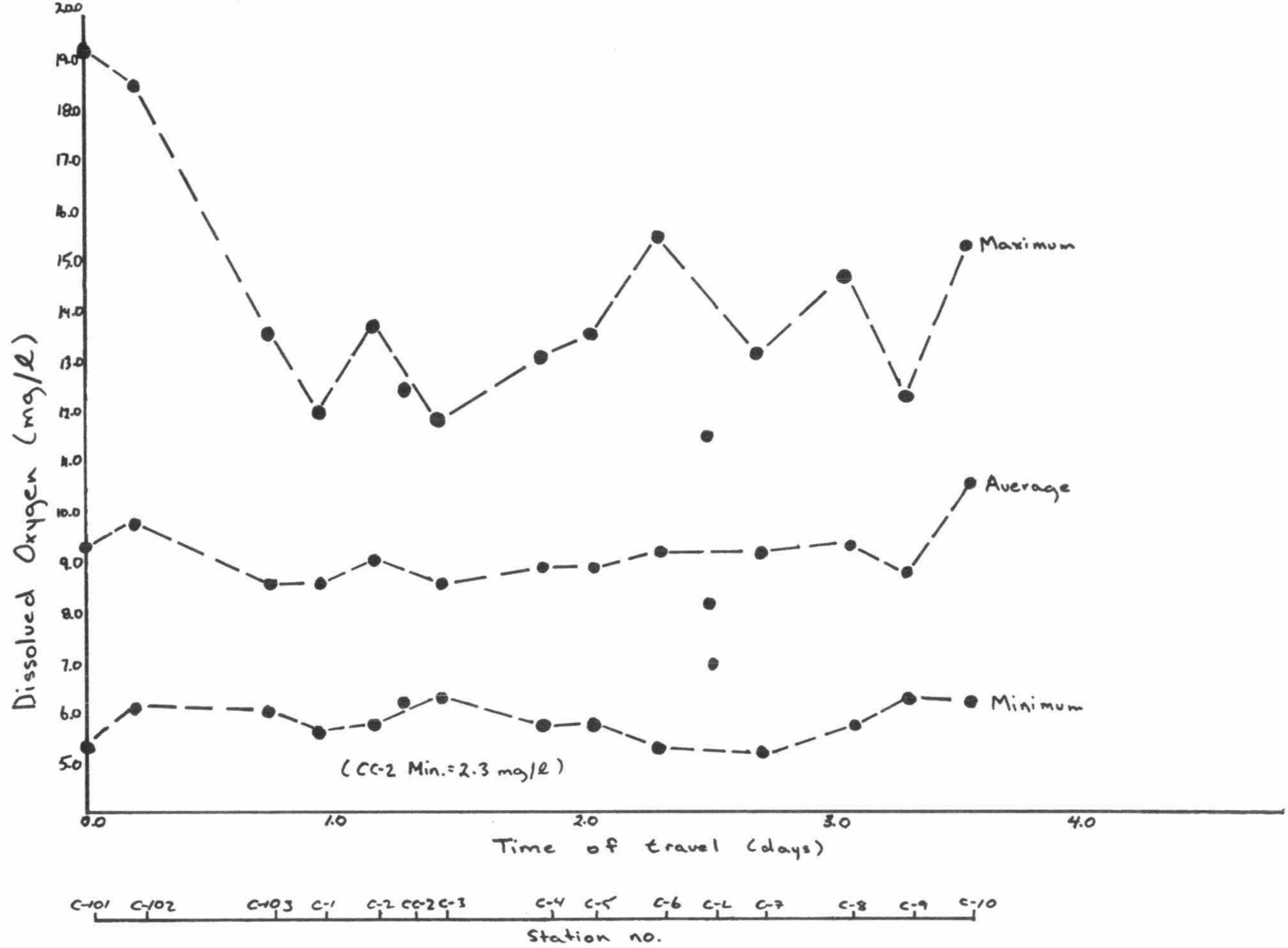

Figure 5. Dissolved oxygen vs time of travel for stations on Catfish Creek, July 12-15, 1976.

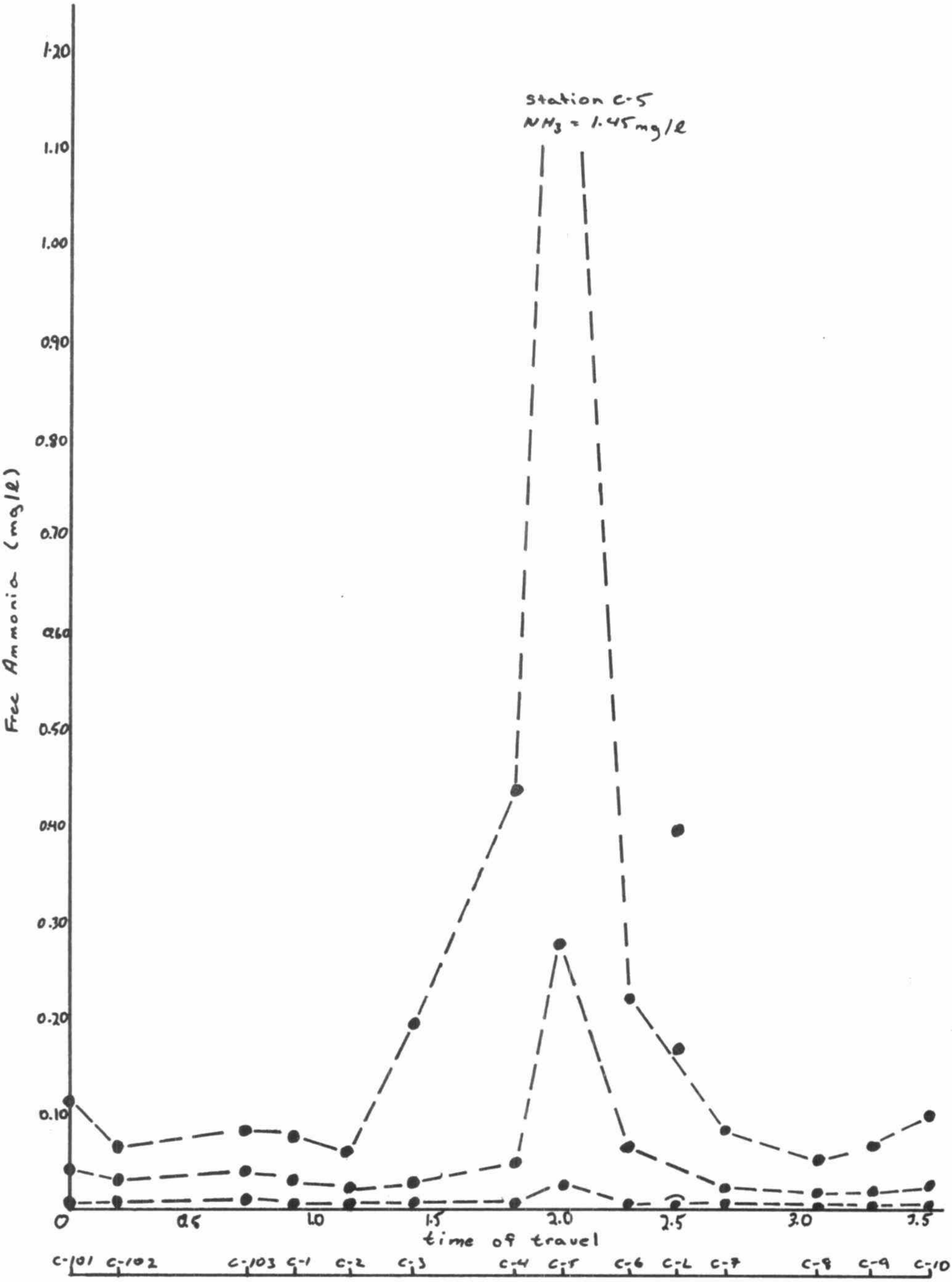

Figure 6. Free ammonia vs time of travel for stations on Catfish Creek July 12 - 15, 1976.

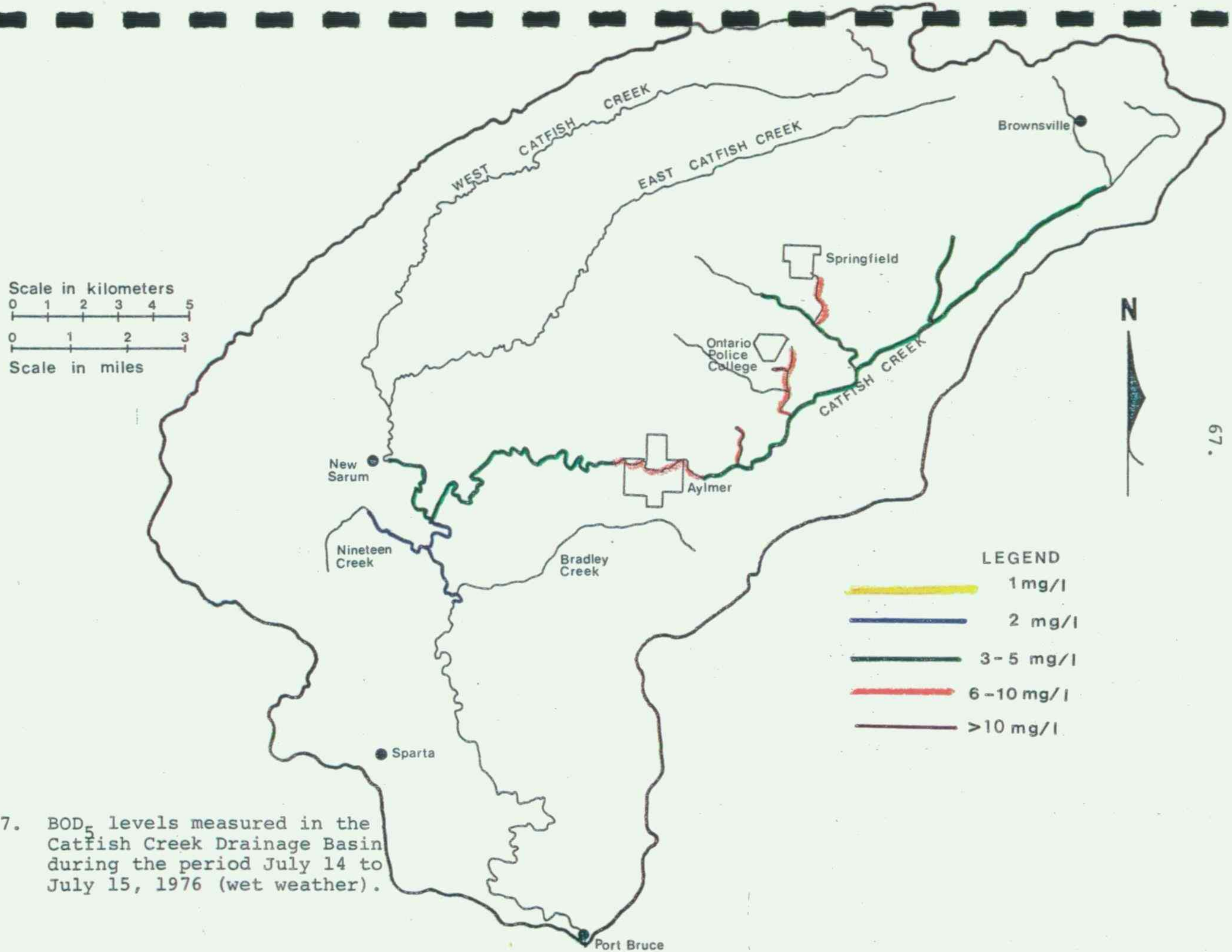

Figure 7. BOD_5 levels measured in the Catfish Creek Drainage Basin during the period July 14 to July 15, 1976 (wet weather).

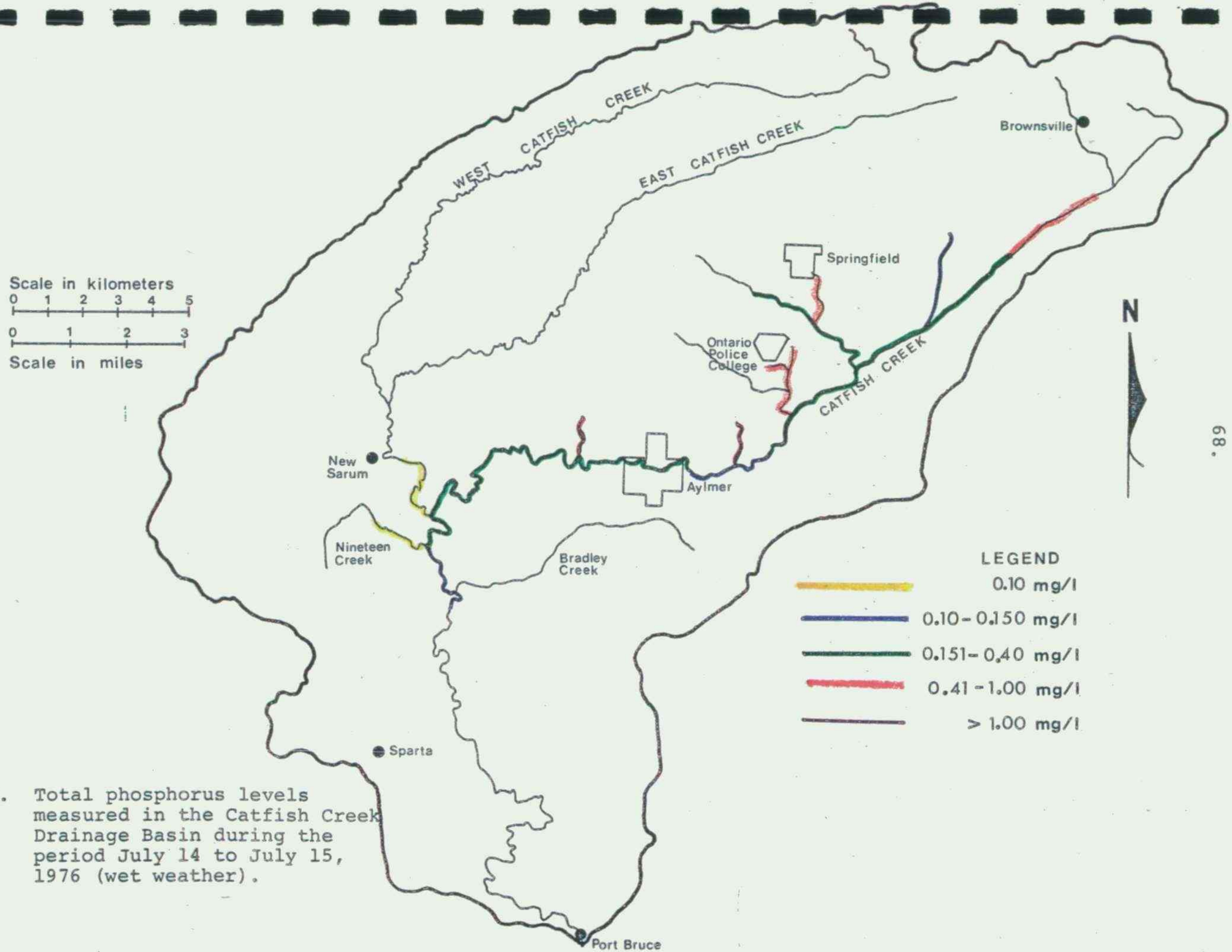

Figure 8. Total phosphorus levels measured in the Catfish Creek Drainage Basin during the period July 14 to July 15, 1976 (wet weather).

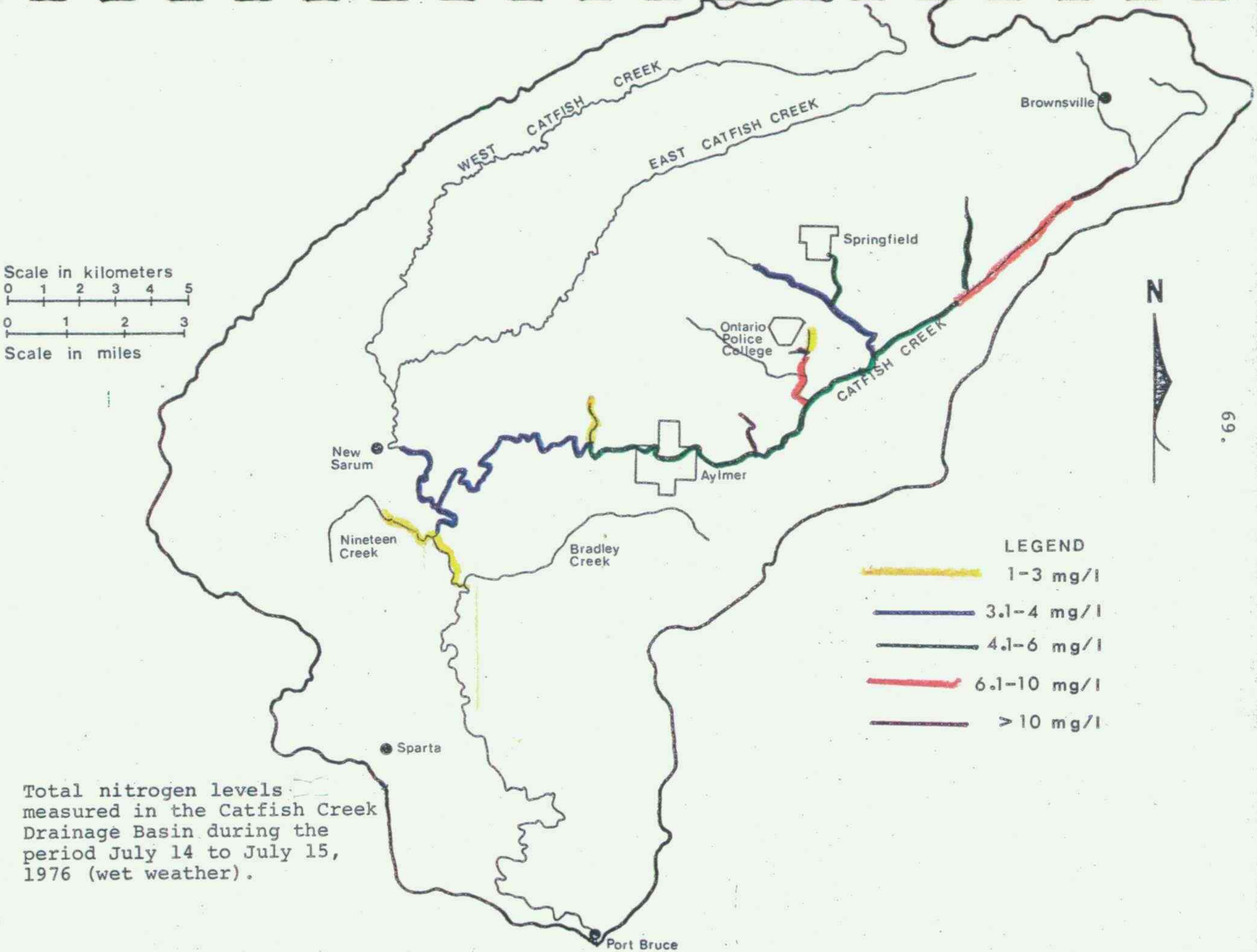

Figure 9. Total nitrogen levels measured in the Catfish Creek Drainage Basin during the period July 14 to July 15, 1976 (wet weather).

APPENDIX III

Effluent Data From Sewage Treatment Facilities in the Catfish Creek Drainage Basin

Table 1. Effluent quality data from the Ontario Police College sewage treatment plant, January to October, 1976. (20 samples).

Table 2. Averages of effluent quality data from the Aylmer waste stabilization ponds, 1976 to 1978.

Table 1. Effluent quality data from the Ontario Police College sewage treatment plant, January to October 1976. (20 samples).

Parameter	Concentration (mg/l)*
BOD_5	14
Filtered BOD_5	6
Suspended solids	59
Total solids	583
pH	7.6
Free ammonia	16.9
Total Kjeldahl nitrogen	28.4
Nitrite	0.36
Nitrate	1.56
Total phosphorus	1.39
Soluble phosphorus	0.15

* All concentrations are given in milligrams per litre except pH.

Table 2. Averages of effluent quality data from the Aylmer waste stabilization ponds, 1976 to 1978.

Parameter	Spring Discharge			Fall Discharge	
	1976	1977	1978	1976	1977
	April 5 to 9 (mg/l)	May 6 to 11	May 9 to 15	September 8 to November 4 (mg/l)	October 5 to November 7
BOD_5	9	11	16	9	8
Suspended Solids	25	52	33	17.6	16.5
Free Ammonia	3.2	2.1	0.3	1.2	1.9
Total Kjeldahl Nitrogen	5.65	5.53	3.29	2.38	4.02
Nitrite	0.07	0.11	0.05	0.13	0.06
Nitrate	0.2	0.1	0.2	0.5	0.1
Total Phosphorus	2.60	2.54	1.68	4.16	1.65
Soluble Phosphorus	2.07	1.70	--	--	1.20
Chlorides	129	140	89	86	110